

Ambix

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THE STUDY OF ALCHEMY.

By Sir ROBERT MOND, LL.D., M.A.

ALCHEMY is the story of Man's observation and reflection on the nature and cause of what we now know as Chemistry.

Like all history, it records not only Man's groping for the truth and for the enrichment of his experiences, but at the same time the widening of the Human Mind and the accompanying evolution of thought.

The remarkable and unexpected changes in appearance that characterize chemical reactions, such as the phenomena of the disappearance and reappearance of an efflorescence in a puddle, the combustion of a heavy branch to a handful of white ashes, and the conversion of metals into dust and their re-conversion to metal, have aroused Man's interest from the earliest ages. His first tendency was to attribute all such phenomena to direct human or super-human agencies.

This conception caused him to adopt practices which were supposed to take effect by persuading, conciliating, intimidating or rendering innocuous these agencies ; and such practices, having as their object the repetition of a favourable result, the avoidance of a danger, or the preservation of health have survived

from the days of the first witch-doctor almost to the present time—a fact to which the Daily Press bears witness.

But Man, from his earliest days, has tried to emancipate himself from superstition, and it is not surprising to find that it is the artisan who first succeeds in his attempt. Accordingly our earliest definite chemical knowledge is to be found in the workshop recipes of the early Assyro-Babylonians and in Egyptian and Chinese writings.

The great Greek philosophers, with their supreme power of abstraction from merely human considerations (have they not stated that Astronomy is merely the practical application of Pure Mathematics?) attempted to reduce the explanation of all natural phenomena, including chemistry, into the ambit of the four elements—air, fire, earth, and water. Even to-day, after the endeavours of Sir Isaac Newton, Lagrange, Lord Kelvin, Minkowski, and Einstein, we are not yet agreed to accept such a simplification. Nevertheless the fundamental ideas as expressed by the Greeks, the practical knowledge transmitted by the Romans, and subsequently by the Arabs, and the dispersion of this accumulated knowledge like a fertilizing dew consequent on the destruction of Constantinople and the Byzantine Empire by the Turks, assisted the rebirth of Europe and planted our feet on the road which leads to our present knowledge.

For instance, most of the processes involved in the modern scientific and technical chemistry such as pulverization, maceration, calcination, solution, sublimation, distillation, filtration, decantation, and even fractional crystallization, were well known from the earliest periods of Alchemy and chemical craftsmanship, and appropriate apparatus was invented, of which some, notably the crucible and the alembic, became the symbols of the early alchemists.

The attempt of pharmacists to give a mystical value to their remedies and of artisans to preserve the secrets of their crafts, the mystifications of the charlatans who extracted gold from those who had it in their attempts to convert base metals into gold by the aid of their long-sought Philosopher's Stone, the introduction of Astrology in the assignation of the principal metals to planets—all these render more difficult our task of deciphering the past history of science. But it is this difficulty, this dispelling of the fog in which the facts are hidden, that makes the task attractive to all who have a living desire for scientific research. This is the task we are setting ourselves, and it is one to which many of our greatest men of science have devoted themselves, among whom we may recall Kopp and Marcellin Berthelot, the great synthetist, who devoted much time and work to the Greek and Arabic writers, as well as to many others. The last lecture ever given by Stanislaw Cannizzaro, to which I was privileged to listen, was on the same subject. It will be the object of our Society to follow the example of these men, and this our Journal will embody the results of our endeavours,

ALBERTUS MAGNUS ON ALCHEMY.

By Professor J. R. PARTINGTON, M.B.E., D.Sc.

THE Greek treatises on the Divine Art, the first works on Chemistry¹, were unknown in Western Europe until the sixteenth century. After the conquest of Egypt in 640 by the Arabs a knowledge of chemistry slowly reached Baghdad, the new capital of the 'Abbāsid Caliphs, who caused Greek manuscripts on medicine and science to be brought from Syria, Egypt and Asia Minor, and had them translated into Arabic by Christians, the most famous being Hunain ibn Ishāq, who died in A.D. 876². Knowledge of alchemy first reached the West in the form of Latin translations from Arabic made in Spain, at Toledo, the capital of the Christian kingdom of Castile. The first of such translations known is that made in 1144 by Robert of Chester of the *De Compositione Alchemicæ* of Morienus³.

Alchemy had probably begun to flourish in Spain⁴ under the Caliph al Ḥakam II (A.D. 961–976), who founded a great library at Cordova and was a patron of scholars.

One of the most influential Latin works on alchemy, the *De Anima* attributed to Avicenna, which claims to have been written in 1012, and to have been translated in 1235⁵, was probably compiled in Spain about 1140⁶. In it the possibility of transmutation is fully upheld. Avicenna (Abū 'Alī Ḥusain ibn 'Abdu' llāh ibn Sīnā, A.D. 980–1036), however, appears to have been a critic of alchemy, and in his philosophical work the *Kitāb al-Shifā* (*Book of the Remedy*) he says :

'As to the claims of the alchemists, it must be clearly understood that it is not in their power to bring about any true change of metallic species. They can, however, produce imitations, tingeing the red [copper] white so that it closely resembles silver, or tingeing it yellow so that it closely resembles gold. They can also tinge the white [metal] any colour they desire, until it bears a close resemblance to gold or copper [*nuhās*]; and they can free the leads [tin and lead] from most of their defects and impurities. Yet in these [products] the essential nature remains unchanged; they are so dominated by induced qualities that errors may be made concerning them, . . . such a degree of

¹ F. Sherwood Taylor, *Ambix*, 1937, i, 20.

² Cf. Partington, *Science Progress*, 1936, xxx, 718.

³ BN Latin MS. 6514, fol. 135; Manget, *Bibliotheca Chemica*, Geneva, 1702, i, 509–19; Steinschneider, *Sitzb. K. Akad. Wiss. Wien*, 1906, cxlix, 69; Thorndike, *History of Magic*, 1923, i, 761, 773; ii, 83, 215; J. W. Brown, Michael Scot, Edinburgh, 1897.

⁴ Ruska, *Z. angew. Chem.*, 1933, xlv, 337; *Forschungen und Fortschritte*, 1933, ix, 393; 1934, x, 293; *Isis*, 1934, xxi, 14; 1935, xxii, 560; 1936, xxv, 191.

⁵ *Artis Chemicæ Principes*, Avicenna atque Geber, Basileæ, 1572.

⁶ Ruska, *opp. cit.*; cf. Haskins, *Isis*, 1925, vii, 70.

perfection may be reached as to deceive even the shrewdest, but the possibility of eliminating or imparting the specific differences has never been clear to me. On the contrary, I regard it as impossible.' As a Parthian shot Avicenna says: 'I could have said a great deal about the alchemists and their claims if I had so desired, but it seemed unprofitable and unnecessary'!⁷

The content of this passage was well known in the thirteenth century in a Latin translation, which is frequently quoted but sometimes attributed to Aristotle (it was perhaps added as a commentary to the fourth book of the *Meteorology* in some manuscripts): Quare sciant artifices alkimie species metallorum mutare non posse sed similia facere possunt et tingere rubeum citrino ut videatur aurum aut tingere albo plumbi immundicias abstergere possunt verum tamen semper erit plumbum quamquam videatur argentum obtinebunt tamen in eo aliene qualitatis. . . .⁸

It is very important to remember that these two contradictory opinions, both attributed to Avicenna, or sometimes one to Aristotle, were available to the great schoolmen of the thirteenth century, and their bewilderment may well be excused. The reaction of such students to the treatises on alchemy coming from Spain is highly interesting, and as an example we could not do better than choose Albertus Magnus.

Albertus Magnus (Albert the Great) was born at or near Lauingen, on the Danube, in Bavarian Swabia, of a noble family of the counts of Bollstädt. The date of his birth is unknown, 1193, 1195, 1205, 1206 and 1207 having been suggested, 1193 and 1206 being most favoured, and the details of his earlier life are also obscure.

Pope Pius XI, in his Decretal of December, 1931, says only that Albert 'was born at the end of the twelfth century'⁹. Albert's connection with the counts of Bollstädt is also not quite certain, but he is called 'of Lauingen' very early¹⁰. Practically every statement about Albert made by one modern authority (*e.g.* Mandonnet) is contradicted by another (*e.g.* Pelster). Albert is said to have studied at Padua and Bologna, and then in the University of Paris. He entered the Dominican order, perhaps at Cologne about 1229 (1223 is also given), and studied and taught in various Dominican houses in Germany (Hildesheim, Freiburg, Ratisbon, Strasburg, Cologne), lecturing at Cologne in 1244-5, where Thomas Aquinas was his pupil. He is said to have taught in Paris in 1245-8 and to have taken the master's degree at the University; in 1248-54 he was at the new Dominican school (*Studium generale*) at Cologne; he was Provincial of his order in Teutonia (Germany Switzerland, Holland, Poland, etc.) in 1254-7, is said to have visited the Papal Court in Rome in 1256 to defend the Dominicans against the

⁷ Holmyard and Mandeville, *Avicennæ de congelatione et conglutinatione lapidum*, Paris, 1927, 41.

⁸ Holmyard and Mandeville, *op. cit.*, 54; Albertus Magnus, *De mineralibus*, III, i, 9.

⁹ Wilms, *Albert the Great*, 1933, 180.

¹⁰ *Ibid.*, 3, 127, 196 f.

attacks of the University of Paris, and was Bishop of Ratisbon in 1260–62, relinquishing this office with the consent of the Pope, so as to be able to devote himself to study. In 1269 he retired to the Dominican cloisters at Cologne, although he is said to have visited Paris again in 1277 to defend Thomas Aquinas against Bishop Tempier. He made his will in January 1279, when he is said by Ptolemy of Lucca to have become feeble-minded, and died at Cologne in 1280. He was canonised in December 1931. This, in brief outline, is all that is known of his life ¹¹.

¹¹ Quetif and Echard, *Scriptores ordinis prædicatorum*, 2 vols. fol., Paris, 1719–21, i, 162; Petrus de Prussia, *Vita Alberti Magni*, Cologne, 1486, Antwerp, 1621; Ptolomæus de Lucca, 'Historia ecclesiastica nova', in Muratori, *Antiquitates Italicae*, Milan, 1738–42, tom. xi; Rudolphus de Novimagio, *Legenda venerabilis Alberti Magni*, Cologne (Koelhoff), 1490—Wilms, *op. cit.*, 223, quotes another edition of Cologne (Guldenschaff), 1484, and the title as *Legenda litteralis de Alberto Magno*, and says the work was reprinted at Cologne in 1928—it is quite different from the work of Petrus de Prussia, with which it is confused by Paneth, *Archiv für Geschichte der Mathematik, der Naturwissenschaften und der Technik*, 1929, xii, 408; J. Sighart, *Leben und Wissenschaft des Albertus Magnus*, Regensburg, 1857; G. von Hertling, 'Albertus Magnus', revised in collaboration with Baeumker and Endres, *Beitr. zur Gesch. d. Philos. d. Mittelalters*, vol. xiv, Hefte 5, 6, Münster, 1914; P. von Loë, 'De vita et scriptis B. Alberti Magni', *Analecta Bollandiana*, 1900, xix, 257; 1901, xx, 273; 1902, xxi, 361; E. Michael, 'Kulturzustände des deutschen Volks während des dreizehnten Jahrhunderts', in his *Geschichte des deutschen Volkes*, Freiburg i. B., 1903, iii, 69 f., 143, 395 f., 445 f.—emphasises his critical attitude; A. Heller, *Geschichte der Physik*, Stuttgart, 1882, i, 179 f.; F. Pelster, *Studien zum Leben und zu den Schriften Alberts des Grossen, Ergänzungsheft zu den Stimmen der Zeit*, ii Reihe, Forschungen, 4 Heft, Freiburg i. B., 1920; *ibid.*, *Z. für katholische Theologie*, 1923, xlvii, 475; M. de Wulf, *History of Medieval Philosophy*, 1926, i, 393; Mandonnet, art. in Vacant and Mangenot's *Dictionnaire de théologie catholique*, i, 666; *ibid.*, *Siger de Brabant, et l'Averroïsme latin au xiiième Siècle*, Fribourg (Suisse), 1889, 50 f., 71; Kennedy, *Catholic Encyclopedia*, i, 261; Michael, *Z. f. katholische Theologie*, 1901, xxv, 37; 1911, xxxv, 561; Pangerl, *ibid.*, 1912, xxxvi, 304, 512, 784; F. Strunz, *Albertus Magnus, Weisheit und Naturforschung im Mittelalter*, Vienna and Leipzig, 1926; *ibid.*, *Ann. Guéhard-Séverine*, 1932, viii, 245, and short bibliography; H. Wilms, *Albert the Great*, transl., with additional notes, appendices and bibliography, by A. English and P. Hereford, 1933, has practically nothing on chemistry, but quotes Mary Ellen O'Hanlon, 'Albertus Magnus, Chemist,' in *Torch*, July–Aug., 1932; U. Dähnert, 'Die Erkenntnislehre des Albertus Magnus,' with (pp. 225–77) a 'Monographische Bibliographie', in *Studien und Bibliographien zur Gegenwartsphilosophie*, Leipzig, 1934, is able to quote on Albert's chemistry, among modern works, only C. Fernandez, 'Alberto Magno y la química medioeval', in *La Ciencia Tomista*, Madrid, 1932, 242–66; *St. Albertus Magnus Festchrift, Sonderheft des Divus Thomas*, Freiburg (Schweiz), 1932, has articles on Albert's astronomy and geology (by J. M. Schneider, p. 41 f.), chronology (by H. Ch. Scheeben, p. 231 f., supporting Pelster's date 1193 against Mandonnet's 1206–7), etc., but not on his chemistry, although it mentions that a *De Alchemia* is included in an Erfurt catalogue of Albert's works, of the end of the fifteenth century (Planzer, *ibid.*, 251); *Revue Thomiste bimestrielle*, March–April, 1931, pp. 230–468, with bibliography, 422 f.; F. A. Pouchet, *Histoire des sciences naturelles au moyen âge, ou Albert le Grand et son époque*, Paris, 1853, 203 f.; Daunou, *Histoire littéraire de France*, xix, 374; Denifle, 'Quellen zur Gelehrten-geschichte des Predigerordens im 13 und 14 Jahrhundert', in *Archiv für Literatur- und Kirchengeschichte des Mittelalters*, Berlin, 1886, ii, 165–248.

Albert's writings are very voluminous: the first edition of his collected works by Peter Jammy¹² is in 21, and the second, edited by A. Borgnet¹³, essentially a reprint of Jammy's, is in 38 volumes. Both editions are uncritical. At least 112 other works, supposed to be apocryphal, are not printed by Jammy. It has been said¹⁴ that Albert's writings constitute 'a perfect encyclopædia both of the knowledge and of the polemics of his time', and that they form a compendium for those who either did not possess the originals, or had not the intelligence to use them¹⁵. A more recent estimate¹⁶, however, asserts that Albert's works, although they served as a mine of information for more systematic authors such as Thomas Aquinas, were not very authoritative, were unsystematic, not very precise, inconsistent, and uncritical, and that he was 'awed by his authorities'. It must be remembered, however, that Peter of Prussia¹⁷ says that Albert, in return for the hospitality of convents in his long journeys on foot, left them books which he wrote as their guest, so that many possessed books in Albert's own hand, and in these circumstances some inconsistencies in his works may well be excused. In actual fact, he also frequently criticises his authorities, such as Pliny¹⁸, although he certainly accepted on trust some absurd statements—as, it is to be feared, do some modern experimenters! His attitude towards magic was the same as that of his contemporaries.

Albert may be regarded as being, to the best of his abilities, a faithful follower of Aristotle, although he did not succeed, as Thomas Aquinas did with better translations, in distinguishing the true text of Aristotle from the Neo-Platonic Arabic commentaries¹⁹. He was certainly an acute critic of alchemy, as will be seen in due course.

Albert's chief work was the incorporation, in the form of a paraphrase, of all the teachings of Aristotle known to him into a vast system of theological (scholastic) philosophy, an amalgamation and reconciliation of Christian theology with the whole body of learning then known in the West. Mandonnet

¹² *Beati Alberti Magni . . . Operum*, 21 vols. sm. fol., Lugduni, 1651.

¹³ *B. Alberti Magni opera omnia*, 38 vols. 4to, Paris, 1890-99.

¹⁴ H. Rashdall, *The Universities of Europe in the Middle Ages*, Oxford, 1895, i, 364.

¹⁵ Mandonnet, *Siger de Brabant et l'Averroïsme Latin au xiii^{ème} Siècle; Collectanea Friburgensia*, Fasc. viii, Fribourg (Suisse), 1889, 50 f.

¹⁶ Sarton, *Introduction to the History of Science*, 1931, ii, 934 f.

¹⁷ *Vita Alberti*, 1621, 203 f., 213.

¹⁸ Thorndike, *History of Magic*, 1923, ii, 540 f.

¹⁹ Mandonnet, *op. cit.*, 57 f.; *ibid.*, Vacant and Mangenot, *Dictionnaire de théologie catholique*, Paris, 1909, i, 672: 'la gloire et l'influence d'Albert consistent moins dans la construction d'un système de philosophie originale, que dans la sagacité et l'effort qu'il a déployés pour porter à la connaissance de la société lettrée du moyen âge le résumé des connaissances humaines déjà acquises, créer une nouvelle et vigoureuse poussée intellectuelle dans son siècle, et gagner définitivement à Aristote les meilleurs esprits du moyen âge'; J. Bonné, *Die Erkenntnislehre Alberts des Grossen mit besonderer Berücksichtigung des arabischen Neoplatonismus*, Dissert., Bonn, 1935.

says his encyclopædia, begun in 1245, was practically finished in 1256, but he revised it repeatedly till the end of his life ; Pelster says Albert wrote extensively in the later years of his life. Albert was, during his lifetime, recognised as an outstanding figure in the world of learning : even Roger Bacon, who criticised him severely, made him the equal of Aristotle, Avicenna and Averroës²⁰. He was well acquainted with Arabic science and philosophy then coming to Europe in Latin translations. In his works Albert also incorporated a number of personal observations, especially in natural history, a subject which he was able to study in his numerous travels on foot as a member of his order²¹.

In spite of frequent assertions to the contrary, he often shows a scientific attitude. He was, however, much less original than Roger Bacon and less systematic and self-consistent than his pupil Thomas Aquinas, although Thomas is less original in the domain of natural science. A resemblance, which may not be accidental, between Albert and the early Oxford Franciscans (Grosseteste, Bacon, Thomas of York) has been pointed out^{21a}.

A man of such universal knowledge as Albert—he was called *Doctor universalis*—could not, in his time, hope to escape the accusation of being a magician : his pupil Ulrich von Engelbrecht called him ‘skilled in magic’ (*in magicis expertus*)²², and Trithemius²³ says he was *magnus in necromantia, major in philosophia, sed maximus in theologia*. In common with his learned contemporaries, Albert believed in magic, of which he thought there were two kinds, an evil magic depending on the participation of demons, and a natural magic depending also on the forces of nature and the stars, but not making use of demons, incantations or divination. He also accepted the belief in talismans and amulets from his Arabic authorities²⁴. The fable of his making a talking head of bronze (which Thomas Aquinas broke with a hammer to stop its chatter when working in his cell) has been connected also with other great men, such as Roger Bacon²⁵, but the story of the magic garden at Cologne, which Albert caused to bloom in the midst of winter on the occasion of a visit in 1249 of Duke William II of Holland²⁶, is peculiar to him. The works : *De secretis mulierum* ; *Liber aggregationum sive de virtutibus herbarum, lapidum*

²⁰ *Opus tertium*, ed. Brewer, 1859, 30 : Nam sicut Aristoteles, Avicenna et Averroës allegantur in scholis, sic et ipse.

²¹ *De animalibus*, edit. by H. Stadler, *Beitr. zur Gesch. d. Philos. d. Mittelalters*, xv–xvi, 1916–23 ; *Alberti Magni de vegetabilibus libri vii. Editionem criticam ab Ernesto Meyero coeptam absolvit Carolus Jessen*, Berolini, 1867.

^{21a} Anon., *Encycl. Brit.* 14 ed., 1929, i, 527.

²² Petrus de Prussia, *Vita*, 1621, 126.

²³ *Chronicon Sponheimensis* ; in his *Opera*, Frankfurt, 1601, ii, 281, from John de Beka, died c. 1350.

²⁴ Thorndike, *Magic*, ii, 554 f.

²⁵ Bayle, *Dictionnaire historique et critique*, 1740, i, 129.

²⁶ Trithemius, *Chron. Sponheim.*, *Opera*, 1601, ii, 281, from de Beka ; H. Thoemes, *Albertus Magnus in Geschichte und Sage*, Cologne, 1880, 155 ; Rodwell, *Birth of Chemistry*, 1874, 87 ; E. H. F. Meyer, *Geschichte der Botanik*, Königsberg, 1857, iv, 20 f.

et animalium ; and *De mirabilibus mundi*, all issued in a very large number of editions, some before 1480, are not by Albert, but were written not long after his time ²⁷.

The treatise *De mirabilibus mundi*, attributed to Albert, which is extant in 14th century MSS. and appeared in print from 1472 ²⁸, is regarded by some as genuine ²⁹, by others as doubtful ³⁰, and by others as spurious ³¹, perhaps compiled by a pupil of Albert's from material derived from Arabic sources ³². It is of particular interest as containing recipes for alcohol, Greek fire and gunpowder similar to those in the work attributed to Marcus Græcus ³³. Albert ³⁴ mentions a Magor Græcus with Hermes, Geber Hispalensis, etc., as an authority on engraved gems. The recipes are :—

Ignem græcum sic facias. Recipe [sulphur] vivum, tartarum, sarcocollam, picolum, sal coctum, petroleum et oleum commune. Fac bulire bene, et si quid imponitur in eo, accenditur, sive lignum sive ferrum, et non extinguitur nisi urina, aceto vel arena ³⁵.

Ignis volans. Accipe librum unam sulphuris, libras duas carbonum salicis, libras sex salis petrosi, quæ tria subtilissime terantur in lapide marmorei, postea aliquid posterius [pulveris] ad libitum in tunica de papyro volanti, vel tonitruum faciente, ponatur. Tunica ad volandum debet esse longa, gracilis, pulvere illo optime plena, ad faciendum vero tonitruum brevis, grossa et semiplena ³⁶.

'Greek fire is made thus. Take native sulphur, tartar, sarcocolla, pitch, boiled salt, petroleum and common oil. Boil them well, and if you put anything in it it will burn, whether wood or iron, and will not be extinguished by urine, vinegar or sand.'

'Flying fire. Take one pound of sulphur, two pounds of willow charcoal, six pounds of saltpetre, which three grind very finely in a marble mortar, then

²⁷ Thorndike, *Magic*, ii, 720 f. ; Sighart, 298 ; Daunou, *HL*, xix, 367 ; Meyer, *Geschichte der Botanik*, iv, 79 ; *Gesamtkatalog der Wiegendrucke*, Leipzig, 1925, i, 263–385.

²⁸ *Gesamtkatalog der Wiegendrucke*, Leipzig, 1925, i, nos. 619, 690, etc.

²⁹ S. J. von Romocki, *Geschichte der Explosivstoffe*, Berlin, 1895, i, 95 f., 103.

³⁰ Thorndike, *History of Magic*, 1923, ii, 720, 723, 737.

³¹ Kopp, *Beiträge zur Geschichte der Chemie*, Brunswick, 1875, iii, 67, 81 ; E. H. F. Meyer, *Geschichte der Botanik*, Königsberg, 1857, iv, 79 (see the whole section on Albertus Magnus) ; Sighart, 298 ; Berthelot, *Chimie au moyen âge*, 1893, i, 91 ; Strunz, 1926, 96 ; it is not mentioned by Peter of Prussia, and Delrio, *Disquisitiones magicarum*, lib. i, cap. 3, Mainz, 1603, 8, says it is spurious.

³² Wellmann, *Abh. K. Preuss. Akad.*, 1921, iv, 29.

³³ Hoefer, *Hist. de la Chimie*, 1866, i, 390, thinks it was derived from this source.

³⁴ *De Mineralibus*, ii, iii, 3.

³⁵ *Alberti cognomento magno de secretis mulierum libellus . . . ejusdem de virtutibus herbarū, lapidum & animalium . . . item de mirabilibus mundi*, v.sm. 8°, Lugduni, 1566, sign. Dd 5 v. ; *Albertus Magnus de secretis mulierum. Item de Virtutibus Herbarum Lapidum et Animalium*, 8°, Amstelodami, 1669, 201.

³⁶ *Ibid.*, 1566, sign. Dd 7 v. ; 1669, 203.

afterwards put as much as you want into a cartridge of papyrus for a rocket or to make thunder. The cartridge for the rocket should be long and thin and well filled with powder, but to make thunder, short, thick and only half-filled.'

The identity of the 'boiled salt' (*sal coctum*), whether common salt or saltpetre, I shall not stay to establish.

Two recipes for the distillation of alcohol (*aqua ardens*) from thick black wine, lime, powdered sulphur, tartar and common salt, are contained in the treatise.³⁷

The parts of Albert's undoubtedly genuine writings which are of chemical interest are mostly contained in his commentaries on physical books of Aristotle³⁸ (which have many incidental references to alchemy) and in his genuine *Mineralium libri V* (or, as it is called in some editions, *De mineralibus et rebus metallicis*) which (if it is the *De lapidibus* frequently mentioned in the *Meteororum*) is one of the early works, perhaps written in Paris in 1240-45³⁹. In these Aristotle is his chief authority. Petrus de Prussia⁴⁰ quotes Albert as saying:

'Augustine in those things appertaining to faith and morals is to be believed in preference to Aristotle if they differ, but if it is a question of medicine, I prefer to follow Galen and Hippokrates, and if natural science is spoken of, I believe Aristotle above all those skilled in natural science.' (Sciendum tamen, quod Augustino in his quæ sunt de fide et moribus plus quam Philosophis credendum est si dissentiunt: sed si de medicina loqueretur, plus ego crederem Galeno vel Hippocrati; et si de naturis rerum loquatur, credo Aristoteli plus quam alii experto in rerum naturis.)

Albert's information on alchemy, however, is largely taken from the *De anima* of Ψ -Avicenna (p. 3) and some other Arabic works, as well as from personal observations of the work of alchemists, probably in Cologne and Paris. He explains (from Aristotle) that flame is burning or ignited smoke⁴¹ and mentions the inflammability of intestinal gases⁴².

³⁷ *Ibid.*, 1566, signs. Dd 5 r. and Dd 7 r.; 1669, 201, 203.

³⁸ *De cælo et mundo*; *Meteororum*; both in Borgnet, iv.

³⁹ *De mineralibus*, Venice, 1495 and 1542; Oppenheim, 1518; Cologne, 1569; in Jammy, ii, and Borgnet, v; Hertling, 5; Pelster, *Studien*, 1920, 137.

⁴⁰ *Vita*, 1621, 288.

⁴¹ *Meteor.*, i, iii, 5; iv, iii, 17.

⁴² *Meteor.*, iii, iii, 4: sicut est videre in ventositate sicca egrediente de ventro hominis: hæc enim si per pannum subtilem emittatur, et candela adhibeatur, tota inflammatur flamma lata et dispersa; also in *Philosophia pauperum*, Pars iv, cap. 17, Borgnet, v, 491; cf. Partington, *Nature*, 1935, cxxxv, 916. The *Philosophia pauperum*, a work more used in the German schools than in the universities, is supposed by Grabmann, 'Die Philosophia Pauperum und ihr Verfasser Albert von Orlamünde', *Beitr. z. Gesch. d. Phil. d. Mittelalters*, Band xx, Heft 2, Münster, 1918, to be by Albert of Orlamünde, a theory already examined and rejected by Quetif and Echard, and again by modern authorities, e.g. Birkenmajer, and Mandonnet (who says Albertus Magnus wrote it in Paris in 1240-44): Wilms, 1933, p. xiv; *Isis*, 1936, xxiv, 479.

Salts are soluble but earths are not, because salts contain narrow pores into which the water enters and splits up the solid into fine particles⁴³.

Metals are formed from water congealed by intense cold and dryness⁴⁴. Mercury (*argentum vivum*; *hydrageros*) is the principle of metals, of which there are seven: lead, tin, iron, bronze (*aes*), brass (*aurichalcum*), copper (*cuprum*), silver and gold, electrum not being a simple metal but made by art⁴⁵. In works of alchemy (*in operibus alchimicis*) mercury is dried by many burnings and mixture with sulphur, or by heating in a furnace with green wood⁴⁶.

In his *De vegetabilibus*⁴⁷ Albert says red roses are bleached by the fumes of burning sulphur—an observation usually credited to Paracelsus.

The *De mineralibus*, of which almost contemporary manuscripts exist⁴⁸, quotes many authorities by name and also as 'the alchemists'.

Albert first explains the old theory of Aristotle that metals are formed from a subtle fatty moisture (*humidum unctuosum subtile*) strongly combined (*fortiter commixto*) with a subtle earth⁴⁹. A new theory is that expounded by Avicenna, both in his *Physica* and in his *Letter to the Philosopher Hazen*, that metals are composed of mercury and sulphur⁵⁰. The theory, which he attributes to Demokritos, that the principles of metals are *calx* and *lixivium*⁵¹, is otherwise unknown. Opinions of Hermes, Demokritos and 'the alchemists of our time' on the generation of stones, he says, are erroneous, the true cause being a 'mineralising force', so that making stones by the operations of alchemy, which is 'a beggarly union of genius and fire', is even more difficult than making metals⁵². They are made by the alchemical coagulation of water or other liquids, as *lac virginis* is made from water percolated through litharge and mixed with alum solution⁵³. Marcasite (of many species) is used by the alchemists to colour metals, but on ignition only useless cinders are left⁵⁴. It has been supposed that Albertus included bismuth among the varieties of marcasite, and this was one of the many later meanings of the name⁵⁵.

⁴³ *Meteor.*, iv, iii, 4; from Aristotle, *Meteor.*, iv, ix, 5; the theory of 'Smekal cracks', Partington, *Chemistry and Industry*, 1935, liv, 490.

⁴⁴ *Meteor.*, iii, iv; Borgnet, iv, 701—the old theory; *De mineralibus*, iii, i, 2.

⁴⁵ *Philosophia pauperum*, Pars IV, in *Meteor.*, 1; Borgnet, v, 478.

⁴⁶ *Meteor.*, iv, iii, 2.

⁴⁷ ii, ii, 7; Borgnet, x, 73.

⁴⁸ Loë, xxi, 364; Mandonnet, *Siger de Brabant*, 136; Mrs. Singer, *Catalogue of Latin and Vernacular Alchemical Manuscripts in Great Britain*, etc., Brussels, 1928–31, 150 f.

⁴⁹ *Mineral.*, iii, i, 2.

⁵⁰ *Mineral.*, iii, i, 4: the *De Anima* of ψ -Avicenna is meant.

⁵¹ *Mineral.*, iii, i, 4.

⁵² *Mineral.*, i, i, 3 f.

⁵³ *Mineral.*, ii, iii, 2; v, 4: the precipitation of lead sulphate.

⁵⁴ *Mineral.*, ii, ii, 11.

⁵⁵ Gmelin, *Gesch. der Chemie*, Göttingen, 1797, i, 106; Kopp, *Gesch. der Chemie*, iv, 110; Libavius, *Alchymia*, Frankfurt, 1606, 72.

Manesia or *magnesia* is a black stone used for purifying glass by melting (*ad puritatem vitri deducit substantiam*).

Book III of the *De mineralibus* is on metals, and contains much personal knowledge obtained by a long stay in a mining district and by visits to mines (*longe vadens ad loca metallica ut experiri possem naturas metallorum*), as well as from enquiries into alchemical transmutations (*de causa quæsi in alchimicis transmutationes metallorum*). These are not a part of physics but of a much better art called alchemy, which is partly natural and partly magical, and is of all arts the one which most closely imitates nature⁵⁶.

Many believe that metals are incomplete gold, which is the only metallic species, and may be turned into gold by the elixir⁵⁷. The same theory is put forward by Abu 'l-Qasim al 'Trāqī, apparently somewhat later than Albert⁵⁸.

Albert quotes the famous dictum of Avicenna that the alchemists cannot change the species, but metals are coloured to look like gold, although Albert says some attribute this statement to Aristotle⁵⁹. Albert tried to procure what he expected Aristotle would have written on the subject, but without success (*in hoc libro sicut in præcedentium Aristotelis tractatum non vidi nisi per excerpta quædam, quæ diligenter quæsi per diversas mundi regiones*)⁶⁰. He was puzzled by the apparent inconsistency of Avicenna, who in his *Alchimia* says the metals may be transmuted by first resolving into the primary matter, and then, by the aid of art, forming into the species of the desired metal. This is really from the spurious work *De anima* (p. 3) and is based on a passage in Aristotle's *Metaphysics*⁶¹, as Roger Bacon knew. Albert continues: 'Those who whiten with white tinctures and yellow with yellow tinctures, without changing the metallic species, are deceivers and do not make true gold and true silver, and all of them work partly or wholly like this, since I have had alchemical gold or silver tested, when it stood six or seven ignitions but was at length consumed and turned, as it were, into dross' (*qui autem per alba albificant et per citrina citrinant, manente specie metalli prioris, in materia proculdubio deceptores sunt, et verum aurum et verum argentum non*

⁵⁶ *Mineral.*, III, i, 1 f.: De transmutatione horum corporum metallicorum et mutatione unius in aliud, non est Physici determinare, sed artis quæ vocetur Alchimia . . . Est autem optimum genus hujus inquisitiones, et certissimum, quia tunc per causas uniuscujusque rei propriam, res cognoscitur, et de accidentibus ejus minime dubitatur, nec est difficile cognoscere . . . quod videmus in arte alchimie fieri, quæ inter omnes artes maxime naturam imitatur.

⁵⁷ *Mineral.*, III, i, 7 f.: illi dicere quod sola auri species est forma metallorum, et omne metallum aliud esse incompletum.

⁵⁸ Holmyard, *Book of Knowledge Acquired concerning the Cultivation of Gold*, Paris, 1923; Sarton, *Introduction to the History of Science*, 1931, ii, 1045.

⁵⁹ *Mineral.*, III, i, 9: Sciant artifices alchimie species permutari non posse, sed similia his facere possunt, ut tingere rubeum citrino, ut aurum videatur: the passage is from the genuine *Shifā* of Avicenna, see p. 3.

⁶⁰ *Mineral.*, III, i, 1.

⁶¹ Lib. vii, cap. v, § 4; Didot ed., ii, 562.

faciunt, et hoc modo omnes vel in toto vel in parte procedunt, propter quod ego experiri feci, quod aurum alchimicorum quod ad me devenit et similiter argentum postquam 6 vel 7 ignes sustinuit, statim amplius ignitum consumitur et perducitur, et ad faciem revertitur). Yet, just as physicians by medicines first purge away corrupt matter and afterwards restore to health, so skilful alchemists work with a great mass of the matter of mercury and sulphur, which are the constituents of metals [the new theory, *cf.* p. 10], and then combine them in due proportions of elementary and celestial virtues for the metal they wish to obtain; for what can be done in Nature's vase can perhaps be done in that vase of art, and what Nature does by the heat of the sun and the stars, can be done by the fire of art' ⁶².

The translation of the important sentence 'propter quod ego experiri feci' as given above ⁶³ seems preferable to that in which Albert himself made the experiment with the alchemical gold ⁶⁴, or the suggestion ⁶⁵ that he is copying from some Arabic opponent of alchemy: Albert specifically says the experiment was tried on his initiative, and the test could easily have been carried out by a goldsmith using processes well known at the time. Alchemical gold must have been circulating in Europe in Albert's time, and the goldsmiths were well able to protect themselves and their clients from such frauds. The process of testing gold was well known even in 1400 B.C. ⁶⁶ In another work ⁶⁷ Albert says the skilled alchemists work during the waxing of the Moon, when they produce purer metals and stones, especially if they are really expert and do not work in haste but await the opportune time when the process will be aided by celestial virtue. He thus recognises the influence of the stars on chemical operations.

In Book IV of the *De Mineralibus (de metallis in speciali)* Albert further expounds the newer theory that sulphur and mercury are the 'father and mother of metals, as Avicenna says'. This book contains a number of chemical facts. It mentions the production of red vermilion by subliming mercury, sulphur and *sal-ammoniacum*, and also its conversion by heating in a closed vessel called the *aludel* into a stone like alabaster, which then by strong heat produces mercury again; also the purification of gold by the 'cement' of soot, salt, and brickdust; the preparation of brass by melting copper with calamine or *tutia* with glass as a flux, which reflects the 'vapour' of the calamine into

⁶² *Mineral.*, III, i, 9; also quoted from a Paris MS. by Quetif and Echard, i, 172; Hopkins, *Isis*, 1925, vii, 71; Berthelot, *Chimie au moyen Age*, 1893, i, 290.

⁶³ From Paneth, *Nature*, 1932, cxxix, 612.

⁶⁴ E.g. Holmyard, *Makers of Chemistry*, Oxford, 1931, 91: 'I myself have tested alchemical gold . . .'

⁶⁵ Von Lippmann, *Entstehung und Ausbreitung der Alchemie*, Berlin, 1931, ii, 35: 'berichtet auf Grund eigener Erfahrung, vielleicht aber auch auf die arabischer Gegner der Alchemie hin'.

⁶⁶ Partington, *Origins and Development of Applied Chemistry*, 1935, 38.

⁶⁷ *De causis elementorum* I, ii, 7; Borgnet, ix, 615.

the copper (*reflectit vaporem lapidis in aes*) ; the cupellation of silver with lead ; the whitening of copper with arsenic and the disappearance of this on heating ; and the production of white lead from lead and vinegar, because the 'mercury' of the lead is expelled to the surface, 'as Hermes says'.

Albert is probably the first to use the name 'affinity' in the sense of chemical relation or attraction. Sulphur burns metals because of its affinity (sulphur propter *affinitatem* naturæ metalla adurit ; quadam subtili affinitate sulphuris ad quam vicinantur omnia metalla). Book V (incomplete in many manuscripts) deals with salts, vitriols (atramentum viride, quod a quibusdam *vitreolum* vocatur) alums, arsenics, marcasites (from which sulphur can be sublimed), *tutia*, *natrum* (soda, not saltpetre), etc. Albert's *De mineralibus* is a very interesting and important work, worthy of a critical edition and translation.

There is no doubt from the above (and many other) passages in his authentic works that Albert firmly believed in the possibility of the transmutation of metals, which, however, he considered very difficult, and that he also knew from personal experience that many alchemists were impostors and their products mere imitations. He says alchemical gold does not gladden the heart (*non lætificat cor*) like the real gold, and is more consumed by fire (*consumitur plus in igne quam aliud*), yet transformation may really be produced by ex-spoliation of properties by alchemical operations, 'as Avicenna teaches'⁶⁸.

Albert had a very good theoretical knowledge of alchemy, derived mostly from his study of Latin translations of Arabic works, and from visits to laboratories, where he made diligent enquiries as to the practice of alchemy. It is doubtful if he himself continuously made chemical experiments, as Roger Bacon did, or that he possessed a laboratory. His great authority, however, must have directed attention to the subject, and about his time many clerics seem to have been engaged in its practical study, and in consequence incurred the displeasure of their superiors⁶⁹.

The study and practice of alchemy were forbidden several times to the Franciscans in the period 1272-1323 (Narbonne, 1272 ; Bordeaux, 1287 ; Trèves, 1289 ; Barcelona, 1323)⁷⁰ and to Dominicans in general chapters at

⁶⁸ Albertus Magnus, *Sententiæ*, II, vii, F, 8 ; Borgnet, xxvii, 154 f.

⁶⁹ Brewer, *Monumenta Franciscana*, Rolls series, 1858, iv, p. xlv ; Daunou, *Histoire litt. de France*, xvi, 98 ; xix, 373, 378 ; Lenglet du Fresnoy, i, 119-30 ; Kopp, *Beitr.*, iii, 64 f. ; Thorndike, *Magic*, iii, 33 ; B. L. H. Martin, *Histoire de France*, 4 ed., 1860 (16 vols. 1855-60, and Index, 1861), iv, 283 ; A. D. White, *A History of the Warfare of Science with Theology*, 2 vols., London, 1896, i, 392 ; J. J. Walsh, *The Popes and Science*, London, 1912, 120 f., 414.

⁷⁰ Narbey, *Revue des questions historiques*, 1885, xxxv, 157 : ' Nous defendons expressement et de toutes nos forces, qu'aucun des frères recherche ou conserve des écrits sur l'alchimie, la magie ou tout autre art inconvenant. Que ceux qui en ont les fassent brûler au plutôt, et que personne à l'avenir ne traite ou ne parle de cet art, sinon, qu'il soit condamné à jeûner au pain et à l'eau le mercredi et le vendredi de chaque semaine, jusqu'à ce qu'il en ait dispensé par le prieur provincial ' (Narbonne, 1272).

Pest (1273), Bordeaux (1287), Trèves (1289) and Metz (1313), with penalties increasing from imprisonment to excommunication, the scandal going on, it is said, in spite of severe prohibitions. The reading of books on alchemy (which must be surrendered to superiors, or burned within eight days) and the study, teaching and practice of the art, and of all operations relating to it, were strictly forbidden⁷¹, yet Daunou (*op. cit.*) thought Albert worked at alchemy and Thomas Aquinas wrote on it.

I quote two passages from Martène and Durand which illustrate in a striking way the growth of the practice of alchemy at the end of the 13th century.

Acts of the General Chapter of Bordeaux, 1287.

‘Further, the Master of the Order, by advice of the Definitors, enjoins upon all Brethren in virtue of their obedience not to study alchemy nor teach it nor practise it to any extent, nor to keep any writings of that science, but to hand them over in good faith as soon as they can to their Priors, and those same Priors shall deliver them to the provincial Priors. Those who are caught or convicted of disobedience to this or other injunctions, besides being punished for disobedience are to be committed to detention in prison.’

At Metz, 1313. ‘Further, since the art called alchemy has been in many General Chapters strictly and on pain of serious punishment prohibited, and from that time up to the present scandalous dangers have arisen in many places belonging to the Order, the Master of the Order enjoins upon all Brethren, according to the counsel and with the agreement and assent of the Definitors, in the power of the Holy Ghost and under penalty of excommunication, that none shall study or be instructed in the said art, or practise it or cause it to be practised, that they shall keep none of the writings if they have any, but within the space of eight days from their knowledge of these presents shall destroy or burn them. Against those who do otherwise he has passed written sentence of excommunication in Council of the Definitors, and sentences henceforth to detention in prison those also whose guilt shall be legally established.’

Acta Capituli Generalis Burdegelæ, 1287.

‘Item, magister ordinis de consilio definitorum præcipit in virtute obedientiæ fratribus universis, quod in alchimia non studeant, nec doceant, nec aliquatenus operentur, nec aliqua scripta de illa scientia teneant, sed prioribus suis restituant quam citius poterunt bona fide, per eosdem priores prioribus provincialibus assignanda. Et qui contra hoc de cetera deprehensi fuerint, aut convicti, præter pœnam inobedientiæ, carcerali custodiæ mancipentur.’

Apud Methim, 1313. ‘Item, cum ars, quæ alchimia vocatur, sit in pluribus capitulis generalibus districtè & sub gravibus pœnis prohibita,

⁷¹ Edmund Martène and Urs. Durand, *Thesaurus novus anecdotorum complectans epistolas, diplomata, etc.*, Paris, 5 vols. fol., 1717, iv; *Acta Capitulorum Generalium ordinis Prædicatorum*, cols. 1769, 1819, 1831, 1943—from a Toulouse MS.; Parrot, *Roger Bacon*, Paris, 1894, 27, says in 1283 but gives no reference.

& adhuc ex hoc in diversis locis ordinis pericula scandalosa surrexerint, præcipit magister ordinis, de definitorum consilio & assensu, & in virtute Spiritûs-sancti fratribus universis, & sub pœna excommunicationis, ut nullus in dicta arte studeat vel discat, operetur vel faciat operari, & scripta de ea si qua habent nulla teneant, sed infra octo dierum spatium à notitia præsentium ea destruant vel comburant. In secus autem facientes, sententiam excommunicationis in definitorio tulit in scriptis, & eos nihilominus de quibus legitimè constiterit, ex nunc adjudicat custodiæ carcerali.'

The decree (*Extravagantis*) of Pope John XXII against the false coiners flourishing in France (the Papal See was then at Avignon) also shows that alchemy was practised by clerics. It reads ⁷²:

'Spondent quas non exhibent divitias, pauperes Alchymistæ; pariter, qui se sapientes existimant in foveam incidunt quam fecerunt. Nam haud dubiè hujus artis Alchymia alterutrum se professores ludificant; cum suæ ignorantia conscii, eos, qui supra ipsos aliquid hujusmodi dixerint, admirantur: quibus cum veritas quæsitâ non suppetat; diem cernunt, facultates exhauriunt, idemque verbis dissimulant falsitatem, ut tandem quod non est in rerum natura, esse verum aurum vel argentum sophistica transmutatione confingant; eoque interdum eorum temeritas damnata et damnanda progreditur, ut fictis metallis cudant publicæ monetæ characteres fidis oculis, et non alias Alchymitum fornacis ignem vulgum ignorantem eludant. Hæc itaque perpetuis volentes exulare temporibus, hac edictali constitutione sancimus, ut quicumque hujusmodi aurum vel argentum fecerint, vel fieri secuto facto mandaverint, vel ad hoc scierint (dum id fieret) facientibus ministraverint, aut scierint vel auro, vel argento usi fuerint vendendo vel dando in solutum: verum tanti ponderis aurum, vel argentum pœna nomine inferre cogantur in publicum pauperibus erogandum, quanti Alchymitum existat; circa quod eos aliquo prædictorum modorum legitime constiterit deliquisse: facientibus nihilominus aurum, vel argentum Alchymitum aut ipso, ut præmittitur, scierint utentibus perpetuæ, infamæ nota respersis. Quod si ad præfatam pœnam pecuniariam exsolvendam delinquentium ipsorum facultates non sufficiant, poterit discreti moderatio judicis pœnam hanc in aliam, (puta carceris, vel alteram juxta qualitatem negotii personarum differentiam aliasque attendendo circumstantias) commutare. Illos verò qui in tantæ ignorantiam infelicitatis proruperint, ut nedum nummos vedunt, sed naturalis juris præcepta contemnunt, artis excedant metas, legumque violant interdicta scierint videlicet adulterinam ex auro, et argento Alchymico cudendo seu fundendo, cudi seu fundi faciendo monetam; hac animadversione percelli jubemus, ut ipsorum bona deserantur carceri, ipsique perpetuo sint infames. Et si clerici fuerint delinquentes, ipsi ultra

⁷² *Corpus juri canonici; in Liber sextus Decretalium D. Bonifacii Papæ VIII. Clementis Papæ V Constitutiones. Extravagantes tum viginti D. Joannis Papæ XXII tum communes*, fol. Lugduni, 1583, *Extravagantes communicum*, lib. v, col. 332; also in Manget, *Bibliotheca Chemica Curiosa*, Geneva, 1702, i, 102; and quoted in full and translated by J. J. Walsh, *The Popes and Science*, London, 1912, 125, 414.

prædictas pœnas priventur beneficiis habitis et prorsus reddantur inhabiles ad habenda.'

'Poor themselves, the alchemists promise riches which are not forthcoming; wise also in their own conceit, they fall into the ditch which they themselves have digged. For there is no doubt that the professors of this art of alchemy make fun of each other because, conscious of their own ignorance, they are surprised at those who say anything of this kind about themselves; when the truth sought does not come to them they fix on a day [for their experiment] and exhaust all their arts; then they dissimulate [their failure] so that finally, though there is no such thing in nature, they pretend to make genuine gold and silver by a sophistic transmutation; to such an extent does their damned and damnable temerity go that they stamp upon the base metal the characters of public money for believing eyes, and it is only in this way that they deceive the ignorant populace as to the alchemic fire of their furnace. Wishing to banish such practices for all time, we have determined by this formal edict that whoever shall make gold or silver of this kind or shall order it to be made, provided the attempt actually ensues, or whoever shall knowingly assist those actually engaged in such a process, or whoever shall knowingly make use of such gold or silver either by selling it or giving it in payment for debt, shall be compelled as a penalty to pay into the public treasury, to be used for the poor, as much by weight of genuine gold or silver as there may be of alchemical metal, provided it be proved lawfully that they have been guilty in any of the aforesaid ways; as for those who persist in making alchemical gold, or, as has been said, in using it knowingly, let them be branded with the mark of perpetual infamy. But if the means of the delinquents are insufficient for the payment of the amount stated, then the good judgment of the justice may commute this penalty for some other (as for example imprisonment or another punishment, according to the nature of the case, the difference of individuals and other circumstances). Those, however, who in their regrettable folly go as far as not only to pass monies thus made but even despise the precepts of the natural law, overstep the limits of their art and violate the laws by deliberately coining or casting or causing others to coin or cast counterfeit money from alchemical gold or silver, we proclaim as coming under this animadversion, and their goods shall be confiscate, and they shall be considered as criminals. And if the delinquents are clerics, besides the aforesaid penalties they shall be deprived of any benefices they shall hold and shall be declared incapable of holding any further benefices.'

Pope John XXII (born 1245) had studied in Paris, probably under Thomas Aquinas, and his attack on alchemy had a result which may be noted in similar cases, *e. g.* Avicenna, viz. he was himself represented as an alchemist and works on this subject were attributed to him⁷³. These were accepted as

⁷³ *L'Elixir des Philosophes, autrement, L'Art transmutatoire, moult utile, attribué au Pape Jean XXII. de ce nom: nō encores veu, ny imprimé par cy devant.* A Lyon, Par Macé Bonhomme, 1557. Avec privilege du Roi; sm. 8°; the two treatises occupy pages 1-150 and 151-205, and they are printed along with treatises attributed to Roger Bacon, Jean de Mehun, etc.

genuine by older authorities⁷⁴, but modern ones⁷⁵ rightly reject them as forgeries.

Albert's interest in alchemy and his great authority would be sufficient reasons for attaching his name to treatises on the subject, and the following treatises are attributed to him :—

1. On Alchemy. (*De Alchimia* ; *Semita Recta*.)
2. Compendium on the Origin and Matter of Metals. (*Compendium de Ortu et Metallorum Materia* ⁷⁶.)
3. Concordance of the Philosophers. (*Concordantia Philosophorum* ⁷⁷.)
4. The Book of Eight Chapters on the Philosopher's Stone. (*Liber octo Capitulorum de Lapide Philosophorum* ⁷⁸.)
5. Treatise of Secrets. (*Secretorum Tractatus* ⁷⁹.)
6. Compound of Compounds. (*Compositum de compositis* ⁸⁰.)

Some of these seem to have been composed soon after his death⁸¹, and the tradition that Albert was a practical alchemist was well established in the following century.

William Langland (b. 1332), or whoever is the author of the A-text of the *Vision of Piers the Plowman* (1362)⁸², speaks of 'experiments in alchemy (experimentis of alconomye ; var. alkenamyē ; alkamyē) of Albert's (Alberdes) making' ; J. F. Picus Mirandulanus⁸³ says Albert was a successful alchemist ; and Michael Maier⁸⁴ has a legend that St. Dominic (who died in 1221) taught

⁷⁴ E. g. F. Pagi, *Breviarum historico-chronologico-criticum illustriorum Pontificum Romanorum gesta, conciliorum generalium acta*, 4^o, Antwerp, 1727, 104 ; Schmieder, *Geschichte der Alchemie*, Halle, 1832, 159 (whose inaccuracies in titles, etc., here as in other places, have been faithfully copied by later writers), says the Latin original is not known.

⁷⁵ Mollat, in Vacant and Mangenot, *Dictionnaire de Théologie Catholique*, 1924, viii, 640, says that : ' Jean xxii n'est pas l'auteur d'un grand traité de *Arte metallorum transmutataria* qu'un grand nombre de bibliographes lui ont attribué '.

⁷⁶ *Theatrum Chemicum* (Zetzner), ii, 123-6.

⁷⁷ *Theatrum Chemicum* (Zetzner), iv, 809-24.

⁷⁸ *Theatrum Chemicum* (Zetzner), iv, 841-62.

⁷⁹ *Artis auriferæ quam chemiam vocant . . . accessit noviter volumen tertium*, Basel, 1610, iii ; B. Mus. MS. Sloane 323, 1 f.

⁸⁰ *Theatrum Chemicum* (Zetzner), iv, 825-41 ; transl. in Poisson, *Cinq traités d'alchimie*, Paris, 1890, 91.

⁸¹ Fourteenth century manuscripts of (1) and (5) are listed, as nos. 117 and 179, respectively, by Mrs. Singer, *Catalogue of Alchemical Manuscripts*, Brussels, 1928-31.

⁸² *A text*, xi, 157 ; *The Vision of William concerning Piers the Plowman*, in three parallel texts, edit. by W. W. Skeat, Oxford, 1886, i, 301 ; ii, 155 ; cf. J. M. Manly, *Cambridge English Literature*, 1912, ii, 1 f., 17, 20 ; *Early English Texts Society*, Orig. series, 1910, no. 139, b, c, d, e ; Thorndike, *History of Magic*, 1934, iii, 422 ; *Encycl. Brit.*, 14 ed., 1929, i, 534.

⁸³ *De Auro*, lib. iii, cap. 1 ; Urselli, 1598, 106.

⁸⁴ *Symbola auræ mensæ*, 4^o, Frankfurt, 1617, 370 ; cf. *ibid.*, 236 f. ; Naudé, *Apologie pour tous les grands personnages qui ont esté faussement soupçonnez de Magie*, La Haye, 1653, 519.

Albert alchemy, so that the latter was able in three years to pay off the debts of his bishopric of Ratisbon, and passed on the secret of the philosopher's stone to Thomas Aquinas. Both Rudolphus de Novimagio⁸⁵ and Petrus de Prussia⁸⁶ say Albert condemned alchemy in his *De mineralibus*, but the former says he wrote a book *de scientia alchemie* which showed the fallacies of the alchemists, and both say that the work *Semita recta* attributed to him is spurious. This is the work also called *De alchimia*. A *De alchimia* and a *Secretum secretorum* are mentioned in old lists of Albert's works, compiled before 1350⁸⁷, but Paneth⁸⁸ thinks this *De alchimia* was an earlier draft (now lost) of part of the *De mineralibus*. A treatise found in an Olmütz manuscript of c. 1350 (*Codex Paneth*), which speaks of the 'frauds of whitening and gilding' which do not stand the fire, may stand in close relation to this (hypothetical) early work of Albert on alchemy. The Roman Catholic authorities follow Quetif and Echard⁸⁹ in supposing that all the alchemical works attributed to Albert are spurious, and although Thorndike⁹⁰ considered that the *De alchimia* may be genuine (or by a 'Brother Albert the Commentator') the *De alchimia* as printed is certainly not by Albertus Magnus, as Kopp⁹¹ had recognised. The work was considered important, and was even translated into Greek⁹². The *De alchimia* as printed in the works of Albert⁹³ and in collections of chemical works⁹⁴, cites Geber, Rasis, Roger Bacon, Arnold of Villanova, and Jean de Meun and even Ulstadius (end of 15th century), and is different in its later part from the 14th century manuscript version⁹⁵, which does not contain the parts headed 'additio' in the printed text, nor the descriptions of lead glazing (ch. 9) and the preparations of soda (ch. 20), mercury sublimate (ch. 38), aqua fortis (ch. 46 f.), and metallic arsenic by heating white arsenic with soap (ch. 34), which are usually attributed to Albert. The chapter on *sal alkali*, giving a derivation of the name (*alkali, id est fæx amaritudinis*, 'dregs of bitterness'), includes a description of solid fused caustic alkali obtained by filtering the lye of oak ashes or ashes

⁸⁵ *Legenda*, Cologne, 1490, Pars ii, cap. 13.

⁸⁶ *Vita*, cap. 16; 1621, 151-161.

⁸⁷ Denifle, *Archiv für Litt.- und Kirchengesch. des Mittelalters*, 1886 ii, 236.

⁸⁸ *Archiv für Geschichte der Mathematik, der Naturwissenschaften, und der Technik*, 1929, xii, 33 f., 408; *Isis*, 1930, xiv, 409; 1933, xix, 390; *Nature*, 1932, cxxix, 612.

⁸⁹ *Script. ordinis prædicatorum*, i, 178, quoting MSS. in England, Paris and Bologna.

⁹⁰ *Magic*, ii, 568; *Isis*, 1929, xiii, 56.

⁹¹ *Beiträge*, iii, 69 f.

⁹² Ἀρχὴ τῆς ἐθελίας ὁδοῦ [= *semita recta*] of [Ἀμ]πέρτος θεοκτονικός; BN Grec 2419; Berthelot, *Intr.*, 208; Lebègue, *Catalogue des Manuscrits Alchimiques Grecs*, Brussels, 1924, i, 65.

⁹³ Jammy, xxi, sep. pagination; Borgnet, xxxvii, 545-73.

⁹⁴ *Theatrum Chemicum* (Zetzner), 1659, ii, 423-58; Gratarolus, *Alchemiæ, quam vocant, artisque metallicæ*, Basel, 1572, i, 611-86.

⁹⁵ BM Sloane 323, f. 61 v.; different text also in a Lehigh MS., Wilson, *Osiris*, 1936, ii, 221.

of soda plant, causticized by quicklime, evaporating to dryness and fusion (*decoque in caldario, donec aqua evanescat, et non det fumum: tunc permittit infrigidari, et erit lapis durus, quod dicitur alkali*) (ch. 20). Lead glazes are mentioned by Petrus Bonus in 1330 (?)⁹⁶, and coloured glazes containing tin and antimony were used on terra-cotta by Luca della Robbia (c. 1450)⁹⁷. The work *De Alchimia* contains (ch. 3) the famous statement: 'sciant artifices alchemiæ . . . ' etc. (see p. 3), which is here attributed to Aristotle, whereas Albert correctly says it is by Avicenna⁹⁸. The author of the *De Alchimia* says he was convinced by his own experiments that transmutation is possible, and he gives eight excellent precepts for the alchemist⁹⁹, among which is the advice to have a special house in a lonely place for the work; to have the funds to buy the materials; and to avoid all commerce with princes or potentates, since 'you have a great deal of annoyance if you do not succeed, and if you do succeed you can never get away'. The word *affinity* is also used (*commixta cum rebus quibus affinitatem non habet*) (ch. 31). The four spirits which tinge metals are mercury, sulphur, orpiment or arsenic, and sal ammoniac; *elixir* is an Arabic word meaning ferment in Latin, 'for just as bread is fermented or leavened by good ferment, so the masses of metals are transubstantiated (*massæ metallorum transubstantiantur*) into white and red by these four spirits, especially by mercury, which is the source and origin of all metals (*quia ipsa est fons et origo omnium metallorum*)' (ch. 11).

The treatises (2)–(5) in the list on p. 17 are vague works which require no special mention, but no. (6), *Compositum de compositis*, which refers to 'our book on minerals', gives a good clear account of the theory of alchemy, and contains some practical recipes, e.g. for the preparation of vermilion and of a white sublimate from mercury, Roman vitriol, and salt; and of a green 'water' (nitric acid) by distilling vitriol, calcined alum and nitre (*sal petreæ; sal nitrum*), which water separates silver from gold (*aurum ab argento separat*) and 'calcines' iron and mercury. By adding sal ammoniac the colour of the 'water' changes from green to yellow (*i.e.* to aqua regia), and it then dissolves gold and sulphur. The solution of silver in the first 'water' (*i.e.* silver nitrate) gives the skin a black stain difficult to remove (*tingit cutem hominis nigro colore et difficulter mobili*). The 'sulphur of the philosophers' is not common sulphur, but the 'spirit of Roman vitriol' (*spiritus vitrioli Romani*), perhaps sulphuric acid. The philosopher's stone is given an infinity of fanciful names by the alchemists (the black crow; the mother; heart and root of all, etc.)¹⁰⁰, but is always the

⁹⁶ *Pretiosa Margarita Novella*, Venice, 1546, 8 v.: stannum et plumbum fuerunt calcinata . . . convertuntur in vitrum sicut faciunt qui vitrificant vasa figuli.

⁹⁷ Gmelin, *Geschichte der Chemie*, Göttingen, 1797, i, 116; *Nouvelle Biographie Générale*, 1863, xlii, 352.

⁹⁸ *Mineral.*, iii, i, 9.

⁹⁹ Borgnet, xxxvii, 549 f.; transl. by T. L. Davis, *The Nucleus*, Febr. 1929; Hoefer, *Histoire de la Chimie*, 1866, i, 382.

¹⁰⁰ Cf. J. Read, *Prelude to Alchemy*, 1936, 92, etc.

same thing. By reiterated projection, 100, 1000, 10,000, 100,000, 1,000,000, and finally an infinite amount, of base metal is transmuted by it.

A more detailed study of these treatises, especially in relation to those attributed to Thomas Aquinas, would be of interest and would throw light on the traditions of alchemy held by the Dominican school in the fourteenth century. This would take us beyond the limits of the present survey, which must now be brought to a conclusion.

METHODS OF RESEARCH IN THE HISTORY OF CHEMISTRY.

By JULIUS RUSKA.

By a strange stroke of fate we give to the science of the structure and transformation of substances the name *Chemistry*, which is sometimes associated with *Cham* or *Chymes*, sometimes with the Egyptian word *keme*, black, and sometimes with the Greek $\chi\acute{\epsilon}\omega$ and $\chi\acute{\upsilon}\mu\alpha$; the origin and meaning of these words have not, as yet, been sufficiently explained. In addition, we have the same word in its Arabic form, *al-kīmīya*, which has come to designate a special stream of chemical theory and practice, which purports to bring about the transformation of base metals into silver and gold and of common stones into jewels, and also the production of a universal medicine, the Elixir of Life. The historians of Chemistry must take into consideration both aspects of the subject—namely, the history of the actual progress which the various nations have achieved through thousands of years towards mastery of the world of matter, as well as the history of alchemy and its aberrations. The historians of Chemistry have struggled with these facts more or less successfully according to the measure of their critical attitude to their sources.

We can try to portray and investigate the progress of chemical technology, which mankind throughout the ages has achieved, by two fundamentally different methods. One method has become possible only in our time. This is based upon the sum-total of the objects excavated from the soil in the course of investigations both of the prehistoric period, in all parts of the world, and also of the historical periods, by which we mean those ages concerning which contemporary documentary evidence has been found in the well-known sites of the old civilizations which have been opened up for research in the last 150 years. Here, after the relative and the absolute age of the objects have been determined by the pre-historian, the Assyriologist, the Egyptologist etc., the last word rests with the technical chemist, who by means of his analyses investigates the composition of metallic alloys, of ceramic material, of pigments and so forth, and can thereby draw conclusions as to the places where the raw material was found and as to the primitive methods of metallurgy, of glass-making and all other techniques. For all these investigations the objects taken from the soil afford material ready to his hand. We must not, however, forget that these give a rather one-sided picture of the methods and scope of the old techniques, because it is only rarely that we find remains of the perishable animal and vegetable materials, which alone could

allow us to draw conclusions as to the technical methods of procedure. A limit is soon reached, and the need to base conclusions upon literary documents becomes ever stronger.

I need not emphasize the tremendous progress which the last century has made in this field. Whereas the older historians of chemistry, down to the time of Kopp, were still exclusively restricted to the extraction of data from classical literature and the Bible, modern Egyptology and Assyriology have revealed to us documents of the first rank, which go back thousands of years. Cuneiform research, above all, has brought to light war reports, commercial documents, collections of receipts, technical instructions, lists of words and objects, the study of which forms a tremendous problem for the history of Chemistry. The connection between these documents and the results of prehistoric research, if investigated with keen critical ability and level-headedness, raises problems, the solution of which must lead to new fundamental knowledge and results of indisputable authenticity.

Let us leave on one side this newest development which is chiefly represented in the monumental work of English authors. There remain the attempts to describe the development of early chemistry purely by means of its literary sources. It is clear that such descriptions depend not only on the nature and the scope of the sources used, but also on the reaction of the author, both to the matter portrayed and to the general state of knowledge and development of historical criticism, corresponding to the period in which the author lived. If we read the older descriptions not only for the purpose of factual orientation, but also with continual attention to the methods of the author as he shapes his material and brings to light his own opinions—if we do this, the reading of the text not only brings us increasing satisfaction, but also a deeper insight into the *dependence upon the age*, which characterizes every work of Chemical history, no matter what its form.

I will gather a few older examples which exhibit with special clearness this dependence on the age, in order to show, by means of the newest efforts of the historians of Alchemy, how the progress of our knowledge is to a great extent determined, not only by the discovery and revealing of new texts, but also by the application of certain critical methods.

We can place the beginning of a history of Alchemy, based on more extended knowledge of the sources, in the XVIIth century, which created a basis for historical treatises and learned disputations by its all-embracing collections of texts such as Zetzner's *Theatrum Chemicum*¹ and even by earlier and smaller collections and separate works. J. J. Manget has placed examples of this literature at the beginning of the first volume of his *Bibliotheca Chemica Curiosa*:

¹ First edition, Ursel, 1602, in 4 vols.; then, Strassburg, 1613–1622, in 5 vols.; second edition 1659–61, with a sixth volume.

it will, however, suffice for our purpose if I confine myself to the *Conspectus Scriptorum Chemicorum Celebriorum* of Olaus Borrichius, and give a brief sketch of the authors mentioned by him ².

In the time of Borrichius it was common knowledge and could not be doubted that the *prima Artis magnæ semina* were inherited from Adam by his more pious and more secretive descendants, that Tubal Cain (perhaps *proprio impetu*) and Bezaleel (but *ipso deo inspirante*) pursued the art of Alchemy, that Hermes Trismegistus was identified with the Biblical Canaan, that his alchemistic wisdom was deposited in the *Tabula Smaragdina*, and that all the knowledge of the later alchemists is ultimately derived from these old and genuine sources. To these oldest sources also belongs the letter of Isis to Horus, the more since Isis, the wife of the King Osiris, was initiated, according to Diodorus, into the secrets of the Art at first hand by her secret counsellor Hermes; here also belongs that fearful oath of Horus not to reveal under any circumstances the secrets entrusted to him. In the same age, about 2500 B.C., according to the statement of the Jesuit Martinus, there also occur the oldest alchemical writings of the Chinese Philosophers. In §§ V–XIII Borrichius gives quite a complete list and description of the Greek authors; in §§ XIV and XV he communicates his opinions as to the later destinies of the Greek Manuscripts and the transmission of the Art to the Arabs, Moors and Occidentals. Among the oldest authors he counts Artephius, who, he states, is mentioned even before the time of Roger Bacon, and who mentioned as his predecessor only Magister Belenus; then follow Morienus and Geber, as the only Arabs whom he thinks worth mentioning. Next comes the succession of Latin alchemists, Roger Bacon, Arnaldus de Villanova, Raymundus Lullius, Petrus Lombardus, Riplaeus, Basilius, Theophrastus and the still more numerous names and works of later authors who extend even to his own time.

I should like to show the way in which Borrichius treats the individual authors by taking Morienus as an example, which may serve us also as a measure of the further development of the history of Alchemy:

‘The Roman Morienus, a believer in Christianity, the author of the book *De Transfiguratione Metallorum*, was also one of the ancient Chemists. Taught by the Alexandrian Adfar, he scorned the joys of this world and freely chose the life of a hermit in the neighbourhood of Jerusalem, where he was later discovered by passers-by, and, through the agency of others,

² The author lived from 1626–90; the work mentioned above was published only after his death (Hamburg, 1697).

The attitude towards Alchemy in the seventeenth century was many-sided and controversial, as is well known to scholars. The following names illustrate this attitude of mind:—H. Conring, 1606–81; Ath. Kircher, 1602–80; W. Ch. Kriegsmann, 1633–79; D. G. Morhof, 1639–91; Becher, 1635–82; Boyle, 1627–91; and many others.

began to be known to King Calid of Egypt. With him he held manifold discourses about the secrets of the Art, in which he spoke many things clearly and in philosophic form: other things, however, he only hinted at in his converse, but did not hide them so much that they were not to be understood by a few advanced students of the Art.'

'Indeed', continues Borrichius, 'this Morienus has explained himself so clearly in many places about the first beginnings of the treatment of the raw material, that I do not know if any one else up to now has declared his opinion more openly and has done a greater service to the whole army of seekers'. Borrichius in a few sentences repeats here what Morienus himself relates in the preface to his work, and has no fault at all to find with the story. We shall soon know more about the details of this account.

About a hundred years after the compilation of Borrichius, there appeared—as an extension of two works of T. Bergman—the *Geschichte des Wachstums und der Erfindung in der Chemie*, by J. Chr. Wiegleb, 1790–92; and, soon afterward, the *Geschichte der Chemie*, by J. Fr. Gmelin, 1797–99. Neither work shows any real advance over Borrichius as far as alchemy is concerned, and I do not want to repeat here what I have already said elsewhere³; I must, however, quote here what Chr. Schmieder says about Morienus in his *Geschichte der Alchemie*, as this work, which appeared in 1832, is the border-line between the naïve and the critical exposition of the history of alchemy, and cannot be neglected by any who may wish to know what was still considered to be history in the first third of the XIXth century. Schmieder places Morienus or Morienus Romanus, also called the Hermit of Jerusalem, in the time before the beginning of the Crusades. I give his statement and his comments thereon verbatim:

'Morienus can, if desired, be assigned to three different nations, because he was descended from a Greek family which settled itself in Rome. He was a Roman born, and wrote Arabic. He definitely is one of the Arabists because, in his own words, he is a pupil of the Arabs; only he is no pupil of the Spanish school, but of the neo-Alexandrian.

'He studied first in Rome, but was persuaded to go to Alexandria by the reputation of the Arab Adfar in order to enjoy his teaching. He became the favourite of this philosopher. After the death of Adfar Morienus went to Jerusalem and bought some land in the vicinity in order to devote himself unreservedly to the Hermetic Art. The produce of the Art, gold and silver, he sent yearly to Jerusalem, and directed it to be used for holy purposes. Unfortunately the receipts are no longer extant; however, the whole story has an edifying tone, and among the alchemists it has given him the reputation of a pious and consequently genuine adept.

'That peaceful sojourn Morienus left when the news reached him that Calid, Sultan of Egypt, had gathered many alchemists round himself

³ *Zweiter Jahresbericht des Forschungs-Instituts für Geschichte der Naturwissenschaften*, Berlin 1929, S. 21–27.

in order to work according to the directions of Adfar. Having arrived there he was soon convinced that the good Sultan was being outraged by rogues who boasted of their knowledge, which in fact they did not possess, in order to profit by the liberality of the highly placed dilettante. Morienus decided to reveal this to the victim of their trickery, and completed the preparation of the Elixir for him, but then escaped without permission and without taking the reward promised him, while leaving behind him the teaching: 'He who understands this needs no reward.' This striking truth did not fail of its effect. The outraged Calid in his wrath caused all the pseudo-philosophers who had duped him for such a long time, to be executed. Calid now yearned for the true philosopher. He sent out scouts in all directions in vain. Finally, the faithful servant Caleb succeeded in coming on the adept in his solitude: he adjured him to come with him because the Sultan was burning with desire for knowledge, and longed to learn from him the complete secret. Morienus agreed to teach the Sultan thoroughly but not for honour and temporal gain, and only on condition that he would allow himself to be converted to Christianity. They negotiated and came to terms, as it seems; but it is only useful to enter into such agreements with Sultans as they wish to keep. In the end Calid had the secret and kept his faith.'

We see that Schmieder to some extent doubts the successes of the teachings of Adfar and wants to make the whole report laughable, but dares not attack the historical character of the persons of the story. This is clearly shown by the author's own comments, which he appends thereto:

'It does not seem that Morienus ever returned to his country, because he has written in the Arabic language only. Consequently he wrote for the Arabs, and this more or less proves the truth of his story, because he would have been convicted of lying, if he had also only begun to write after the death of the Sultan, as is supposed. I am far from doubting his truthfulness, as the Arabs and the Christians honoured him highly as a reliable leader. The Crusades were the occasion of bringing many Arabic writings to Europe, and in this way the work of Morienus also reached Italy. As a pious Christian and a fellow countryman he was especially sympathetic to the Latins: his language, however, prevented many from reading him, until finally Robertus Castrensis took the trouble to translate his works from Arabic into Latin, which, according to his own note, occurred in 1182. Since that time we have his works only in Latin and in the following treatise, which is published under different titles: Morienus, seu, Morienus Romanus, Eremita Hierosolymitanus, *De Transfiguratione metallorum*, etc. etc., Parisiis, 1559.'

I cannot find in the original source any proofs of the assertion of Schmieder that Morienus was descended from a Greek family which had settled in Rome. There it is said:—'Nam in eo tempore fui ego Romæ (unde et ortus fueram) constitutus. Eram autem tunc iuvenis, cuius videlicet mentum prima lanugo nondum obdlexerat, studens scilicet, et doctrina Christianus a primæ ætatis

gradu ab utroque parente effectus : cui etiam se tota iam latinitas detexerat. Audito ergo huius viri nomine et fama, parentes et patriam simul festinus deserui, nec quieti nimiae meos artus exhibui, quousque Alexandriam devenisse.' Morienus also introduces himself as a born Roman to Adfar and the next sentence begins : 'Ego Morienus vocor, natione Romanus, quem videlicet tui nominis et scientiae fama, de parentibus et patria discedere coëgit.'

Just as mistaken is Schmieder's assumption, even though it may be suggested by the name-form Adfar, that the Alexandrian philosopher whom Morienus sought was an Arab. Schmieder should have realized that an Arab, that is a Muslim, could not have revealed to a *cultor Christi* and a devotee of the triune God the *totius divinitatis secreta*.

That Schmieder places Morienus and Sultan Calid in the time before the beginnings of the Crusades is not so bad, even though the text leaves no doubt that Calid is to be understood as the son of Gezid, the son of Macoya, the Ommayyad Prince Hālid ibn Yazīd ibn Mu'āwīyya.

If I have called Schmieder the last representative of the credulous writing of history, H. Kopp can be designated as the last representative of that learned method which, with the most meticulous accuracy and infinite diligence, set down what was supposed to be known, in the XVIIth and XVIIIth centuries, about the Alchemists and their writings, in order to advocate one or the other opinion as the more possible. It is rather tragic that these laborious studies of Kopp have not always led to definite decisions, where this would have been easily possible if his grasp had been a little more firm⁴. Kopp repeats about Morienus in his *Beiträge*, iii (1875, p. 12), briefly what Schmieder and Hoefer had already asserted.

I need not enlarge on the fact that a new age in the History of Chemistry began with M. Berthelot ; that, through him and his co-workers Duval, Houdas and Ruelle, the foundations of a History based on sources, especially of Greek and Arabic alchemy, were at last laid. This epoch-making achievement has not yet been superseded, and to speak of its defects would only suggest thanklessness towards the founder of Alchemical History.

Berthelot also bases what he says of Morienus upon Arabic sources. Ibn al-Nadīm mentioned him in his *Fihrist* (completed 987) among those philosophers who have treated of the Art⁵ ; therefore he is for Berthelot a historical personality. As the teacher of Hālid ibn Yazīd he must have been, as a Syrian monk, one of the first to spread the *culture scientifique grecque* among the Arabs ; only the Arabic portions of his writings have not come

⁴ A detailed study of Kopp's work on the History of Chemistry has appeared in English translation by Prof. R. E. Oesper in the *Journal of Education*, 1937, pt. 1.

⁵ M. Berthelot, *La Chimie au Moyen Âge*, iii, p. 29, no. 28 (Mouyanès).

down to us. These statements of Berthelot agree on the whole with those of E. O. von Lippmann⁶, except that the latter makes Marianus into an Alexandrian scholar, physician and author at the time of the Arabic conquest. Von Lippmann expresses himself contemptuously about the alchemical portion of the Latin translation: 'The work is not excelled by any later writer when it comes to emptiness, lack of clearness and foolish babbling, but does not contain anything that cannot be accorded with the teachings of the latest Greek alchemists, and does not quote any other than Greek authorities. The book probably goes back to an old Arabic text which still remains close to the Greek originals, from which it differs, however, and is to be regarded in its present form as a translation worked-over from the Christian standpoint. However, as an Arabic original is not extant, and forgeries of all kinds warn us to be cautious, no certain opinion can be expressed.'

With this opinion of v. Lippmann the matter might have ended if R. Reitzenstein, as a classical philologist, had not taken possession of the question and come to conclusions which challenged the opposition of the Arabists⁷. It already sounded very peculiar that Reitzenstein should announce his intention to extend his earlier observations to 'Arabic literature', which, according to general opinion, had decidedly influenced the Latin literature of the occident, even though so far there had been no success in proving this in detail (!). Even more, it must have estranged every reader who was intimate with the history of the early Islamic ages that such a critical classical philologist accepted the story of Prince Calid as genuine evidence, and saw in him not only a magnificent exponent of Greek studies but also the author of writings about Alchemy, for the knowledge of which he had to thank his teacher Marianus. With this uncritical repetition of Arabic tradition it was impossible to make further progress. It was first necessary to examine and destroy the whole structure of legend which had grown up round Calid in order to obtain a clear view of the book of Morienus, its composition, its sources, its first form and its further elaboration.

I believe that I have shown by my researches⁸ that the prefatory portions of the text, especially, could not possibly have had a Muslim author, but that an Arabic nucleus is most decidedly present. At a later date I also showed that the introduction of Robertus Castrensis, which is used as preface to the work, does not belong to it at all, but is a re-hash of the genuine introduction to the Seven Tractates of Hermes. But much work has yet to be done. The Arabic writings which relate to the association between Chalid and Stephanus (the Adfar of the Morienus book) will have to be examined more closely in order to follow in detail the chain of forgeries that herein lies before us.

⁶ *Entstehung und Ausbreitung der Alchemie*, 1919, S. 358 ff.

⁷ *Alchemistische Lehrschriften und Märchen bei den Arabern*, Giessen, 1923.

⁸ *Arabische Alchemisten*, I, Heidelberg, 1924.

If I have confined my remarks about the methods of research in Chemical History to the Morienus text, which is a rather unimportant feature of the history as a whole, I have done so because by this example it is possible to show how stubborn a hold on life old prejudices have, and how difficult it is to overcome them. Of course there remain to be solved many problems of deeper and wider import than the above, and it may perhaps be permissible to point to the completion of the work on Rāzī which has occupied me, with interruptions, for more than 15 years. In Borrichius there is to be found no word about Rāzī. Schmieder is the first who puts forward any biographical notice of him (*op. cit.*, p. 95) :

'Rhases is supposed to have written twelve books about alchemy, of which nothing remains except a number of quotations which occur in the works of the Latin Alchemists. The extant alchemical writings are said not to correspond with these quotations, and therefore may be interpolations If the genuine 12 books of Rhases deserve the opinion held by his contemporaries, their loss will not have to be very much lamented.'

H. Kopp devotes to Rhases one line of text and a footnote which is especially concerned with the book, falsely ascribed to him, *De Aluminibus et Salibus*. We have to thank Berthelot for the first reference to the book *Liber Secretorum Bubacaris*, which is the Latin version of Rāzī's *Kitāb sirr al-asrār*⁹, and E. Wiedemann for the first extracts from the Arabic texts¹⁰. E. O. von Lippmann in 1919 (*op. cit.*, p. 400) sums up the state of our knowledge, and in Easter 1921 I devoted my attention to the text of Göttingen, which in this year I was finally able to publish with a commentary and translation.

Here is a basis for further researches which must extend into the Islamic as well as into the late Latin period. Up to that time I could testify to the existence of an old translation in Palermo : I have since analysed the edition of the book which is contained in the Codex Riccardianus in Florence ; from this there seem to lead direct lines of connection to Geber's *Summa Perfectionis Magisterii*.

I could also point out that among the technical chemical receipts of the book *Liber Sacerdotum* are to be found many borrowings from Rāzī. I believe that by the disclosure of the influence of Rāzī's chief work one of the most important sources of technical alchemy has been revealed, and I am convinced that only by following this path of patient and detailed research will it be possible gradually to set up a true history of alchemy in place of a tissue of legends.

⁹ *La Chimie au Moyen Âge*, i, 1893, pp. 306-10.

¹⁰ *Über chemische Apparate bei den Arabern*, Beiträge aus der Geschichte der Chemie (Kahlbaum-Gedenkschrift), 1909, S. 234 ff.

We continually need new texts, we need summaries of contents, translations and commentaries, and we cannot be grateful enough for the new material which is contributed to the history of alchemy by such publications. But in order to achieve a real history of alchemy we also need the application of the keenest critical methods. We need researches which will bring to us, so to speak, legally documented data about the influence of the great alchemists. Herein I ask nothing which is not also required by other historical sciences in their own special spheres.

The inevitable consequence of critical philological work is the destruction of illusions, but there remains no other way of clearing the undergrowth of legends and of approaching historical truth.

Berlin, 1937.

THE ORIGINS OF GREEK ALCHEMY.

By F. SHERWOOD TAYLOR, Ph.D., M.A., B.Sc.

Definition of Alchemy.

ALCHEMY is not easily defined. Some would narrow its meaning to 'the Transmutation of Metals'; others would include within its range all that pertains to the notions of exaltation and regeneration, whether of metals or of the human mind. Alchemy is identical neither with mysticism nor with metallurgy. One of the earliest alchemical texts, the *Φυσικὰ καὶ Μυστικά* of Demokritos (c. A.D. 100), succinctly expresses by its title the nature of the Art it describes—which may be defined as:—*An art, purporting to relate to the transmutation of metals, and described in a terminology at once Physical and Mystical.*

An inquiry into the origins of Alchemy may proceed by two methods. The safer and more certain is to seek in the earliest texts for evidence, direct or indirect, of their sources: the more ambitious is to extract from these texts—no easy task—their essential ideas, as of transmutation, regeneration, symbolic representation; and to seek to trace these ideas in the philosophies and cults contemporary with or preceding the earliest of alchemical texts. The former and lighter task is here essayed.

Sources of the Earliest Alchemical Texts.

Alchemical texts have been written in every century from the second century B.C. to the nineteenth century A.D.; they hail from every country in Europe and the Near East, from Persia, India, China, and Tibet. But when we seek the origin of the alchemical tradition, we can find direct evidence of the existence of Alchemy before, say, A.D. 300 only in two cultural centres—China and Hellenistic Egypt. Of the early Chinese texts but little is at present known: the texts hailing from Hellenistic Egypt¹ are both voluminous and of great interest. It is with these texts that this article will be chiefly concerned.

Possible Assyrian Source of Alchemy.

In 1925 Robert Eisler drew attention to a remarkable passage contained in an Assyrian clay tablet of the eighth century B.C. The text in question is concerned with the manufacture of glazes, enamels, and precious stones, and

¹ Prof. T. L. Davis advances the view (*Scientific Monthly*, 1936, xliii, 551–558) that the texts are not strictly alchemical, in that the operations they describe are directed to a staining or colouring of metal, not to a supposed transmutation. With this view I disagree, and hope to express my views in a subsequent number of *Ambix*.

appears to allude to the silvering of bronze vessels ; its content therefore is distantly related to the subject of Alchemy. The hall-mark of Alchemy is the combination of a spiritual and practical aspect in the making of precious materials ; it was therefore of great interest to find that in Assyria magical practices were associated with the setting up of a furnace for such purposes. Here is a translation ² of the text :—

‘ When thou settest out the (ground) plan of a furnace for “ minerals ”, thou shalt seek out a favourable day in a fortunate month and thou shalt set out the (ground) plan of the furnace. While they are making the furnace, thou shalt watch (them) and shalt work thyself (?) (in the house of the furnace) : thou shalt bring in embryos³ (born before their time) another (?), a stranger shall not enter, nor shall one that is unclean tread before them : thou shalt offer the due libations before them : the day when thou puttest down the “ mineral ” into the furnace thou shalt make a sacrifice before the embryos : thou shalt set a censer of pure incense, shalt pour *kurunnu*-beer before them.

‘ Thou shalt kindle a fire underneath the furnace and shalt put down the “ mineral ” into the furnace. The men whom thou shalt bring to be over the furnace shall cleanse themselves and (then) *thou shalt set them to be over the furnace or “ crude minerals ”*.

‘ The wood which thou shalt burn under the furnace shall be styrax, thick decorticated billets which have not lain exposed in bundles, (but) have been kept in leather coverings, cut in the month of Ab. This wood shall go underneath thy furnace.’

This text antedates Western Alchemy by some eight centuries, and there seems to be a consensus of opinion against regarding it as connected with true Alchemy, on the ground that the association of religious or magical rites with the initiation of a new enterprise, in this case the building of a furnace, is in no way exceptional or necessarily dependent on the purpose to which the furnace was to be put.

Early Chinese Alchemy.

The Chinese alchemical texts which have been translated amount only to a few dozen pages : it is difficult therefore for one who is not a sinologue to give any adequate account of them.

The central purpose, at least of practical Chinese Alchemy, seems to have been the prolongation of life by artificially prepared gold—believed to be of greater efficacy than common gold. Chinese Alchemy is connected with Tao-ism, the philosophy of Lao-tzu, who lived some four centuries before the earliest mention of Alchemy. Essential to his doctrine is the idea of the whole universe being informed by Tao, which may be thought of as analogous to the influence of destiny, the *εἰμαρμένη* of the Greeks. The doctrine of Tao led to a mystical system whereby the individual could merge himself in Tao and so

² Campbell Thompson, *Chemistry of the Ancient Assyrians*, Luzac, 1925.

³ Or crude minerals.

be freed from the bonds of space and time. This doctrine, like that of every philosophy or religion, was modified by smaller minds to suit their beliefs and desires, chief among which, as always, was the desire for long life. Many were unwilling to undergo the mental and physical discipline of the mystic's life in order to free themselves from the bondage of destiny: these preferred to believe that a medicine could confer the principle of longevity. It was a doctrine associated with Taoism that all things were composed of two principles—*Yin*, the negative principle of femaleness, cold, darkness, death, and matter, and *Yang*, the positive principle of maleness, heat, light, life, and soul. Certain substances, vermilion (cinnabar), gold, silver, and jade, were believed to be particularly rich in *Yang*. Gold, it was believed, could be alchemically prepared from vermilion, and such gold was naturally supposed to have a peculiar power of prolonging life.

This is the central notion of Chinese practical Alchemy, but is totally absent from the Western Alchemy of the first millennium A.D.

The earliest ⁴ notice of Alchemy in Chinese Literature is contained in the *History of Ssuma Ch'ien*, which appears to be a later addition to the *Treatise on the Sacrifices of Feng and Shan*. The following passage from the *Han Shu* XXV has been translated by Waley, and in the opinion of the latter dates from the first century A.D.:—

'(The wizard Li) Shao-chun said to the Emperor (Wu Ti of Han): "Sacrifice to the stove (tsao) and you will be able to summon "things" (*i. e.* spirits). Summon spirits and you will be able to change cinnabar powder into yellow gold. With this yellow gold you make vessels to eat and to drink out of. You will then increase your span of life".'

As the Emperor Wu Ti lived from 140–86 B.C. and it is unlikely that the incident related was the beginning of Chinese Alchemy, we must suppose that the latter was in existence at least as early as 200 B.C., and may therefore antedate our earliest Greek alchemical writings by some two centuries.

A considerable work on Alchemy, the *Ts'ang T'ung Ch'i*—attributed to Wei Po-yang, perhaps pseudonymously—belongs to the second century. Many later works exist. The tendencies of later Chinese Alchemy are hardly relevant to our study of origins. Suffice it to say that, as in the West, it divided into a practical gold-making craft and a mystical religion in which mental transmutations were operated upon the souls of metals which were mystically equated to various organs of the body.

There seems little reason to believe that the Alchemy of Hellenistic Egypt had any contact with that of China. There is some slight likeness of materials: but to the early Alchemy of the West are unknown the two central notions of

⁴ Prof. William H. Barnes has drawn attention to a doubtful earlier reference in the writings of Chuang Tzu (fourth to third century B.C.) ('Possible references to Chinese Alchemy in the fourth and third century B.C.', W. H. Barnes, *China Journal*, xxiii, 2, p. 75).

Chinese Alchemy, namely, the prolongation of life and the Philosopher's Stone, a minute portion of which would transmute a large quantity of base metal. Both these notions appear in the West for the first time in the alchemical texts of the Arabs.

The Greek Alchemical Texts.

The authors of the Greek alchemical texts attribute the source of their art to Ancient Egypt. The force of this evidence is much weakened by the tendency of the classical world to attribute all wisdom to the priests of Egypt. The alchemist, moreover, who could believe that the prophet Moses was the author of a very practical set of alchemical recipes does not command our confidence when he speaks of the origin of his art. There is, however, no small amount of internal evidence for an Egyptian source. No direct written evidence of the existence of the Alchemy as defined at the beginning of this article is to be found in the records of ancient Egypt, of ancient Persia, of the Hittites, or of classical Greece and Rome, nor do the records of Babylon and Assyria reveal anything concerning Alchemy except the doubtfully alchemical text which has already been discussed.

The quest of the making of gold appears full-fledged in Egypt at a date which cannot be far from A.D. 100. Our sources of knowledge concerning it are derived from papyri and manuscripts. The earliest alchemical document is a fragment of papyrus so far mutilated that we can only tell that it is concerned with the making of silver: its date is about A.D. 70. Of far more interest are two papyri, written at a date not far from A.D. 300 and now in the libraries of Leyden and Stockholm. Whether these papyri are truly alchemical will be a matter for discussion. Suffice it to say that they deal with recipes for artificially preparing gold, silver, asemos (a white silver-like metal), precious stones, and purple; and that, although they contain nothing that is mystical, they make allusion to the alchemist Demokritos, an allusion which indicates that their authors were acquainted with true Alchemy.

The works of the Greek alchemists proper are to be found in very numerous manuscripts, distributed through the libraries of Europe. If we exclude the works written after A.D. 1000, which generally appear in manuscripts separate from those containing the works of the more ancient authors, it may be said that all these manuscripts derive from two originals:—

1. The manuscript Marcianus 299 of Venice, copied in the tenth or eleventh century.
2. The manuscripts Parisinus Græcus 2325 of the thirteenth century and 2327 of the fifteenth century, which latter seems to be a more complete copy of the original from which the former, Parisinus Græcus 2325, was taken.

It would appear that a collection of alchemical manuscripts was made in Byzantium in the seventh or eighth century which, after some losses and mutilations, appears as Marcianus 299 and the numerous manuscripts copied therefrom. The original seventh century collection was probably copied before all of these mutilations had occurred, and numerous later texts were added to the copy: the result was the manuscripts Parisinus Græcus 2325 and 2327 and their numerous copies. The filiation of these manuscripts has been a matter of controversy, but the above summary is not far from the truth.

Most of the Greek alchemical writings are edited and translated in Berthelot's invaluable *Collection des Alchimistes Grecs* (Paris, 1888), which, however, omits the work of Stephanus, which is found in Ideler's *Physici et Medici Græci Minores* (Berlin, 1841). Berthelot also omits the alchemical poems: these are to be found in Fabricius, *Bibliotheca Græca* VIII (1802) and in Goldschmidt's *Heliodori Carmina Quattuor* (*Religionsgeschichtliche Versuche und Vorarbeiten* XIX, 2, Giessen 1923).

The chemical Papyri have been published by O. Lagercrantz, *Papyrus Græcus Holmiensis* (Upsala, 1913) and by Berthelot (*Archéologie et Histoire des Sciences*, Paris, 1906).

An examination of the miscellaneous collection of Greek alchemical texts enables us to classify their authors with fair certainty into (1) those who wrote before Zosimos of Panopolis (c. A.D. 300) formed his great collection of alchemical material, and (2) the authors later than Zosimos; these latter produced little else but commentary. Zosimos himself occupies an intermediate position, being at once an original author and a commentator on earlier works.

These early writings are of exceedingly diverse character. Some are very practical laboratory treatises: others are almost wholly mystical. It is not possible, as might have been hoped, to trace mystical and practical Alchemy to a single source. Rather, as we approach the earliest texts, we find a more definite division between these aspects of the Art.

The Chemical Papyri.

Almost wholly practical are the papyri of Leyden and Stockholm. The authors of these are unknown, but the format and calligraphy indicate that they were written towards the end of the third century A.D. They contain some hundreds of recipes for the preparation (or falsification) of gold, silver, aemos, precious stones, and dyestuffs. It is interesting that these should be lumped together in a single treatise, and it is clear that the colouring of a metal so as to imitate gold or silver was thought of as fully analogous to the dyeing of a piece of cloth ⁵.

⁵ For the further development of this notion, see Arthur John Hopkins 'Earliest Alchemy', *Scientific Monthly*, vi, 1918, 530-7; 'Bronzing Methods in the Alchemistic Leyden Papyri', *Chemical News*, lxxxv, 49; *Alchemy, Child of Greek Philosophy*, Columbia University Press, 1934.

How did the authors of these papyri try to make gold and silver? Here is a recipe :—

‘Asemos ⁶ one *stater* or copper of Cyprus 3 *staters*; 4 *staters* of gold; melt them together.’

In other words, turn 24-carat gold into 19-carat or 10-carat gold. This type of recipe is common enough. It seems that it was thought of not as a mere mixing, say, of gold and copper, but as an increase of the quantity of gold at the expense of its quality. Here is a less crude recipe :—

‘To increase the weight of gold, melt it with a fourth part of *cadmia*. It will become heavier and harder.’

Cadmia was an impure mixture of oxides of such metals as copper, arsenic, etc., obtained from copper smelter’s flues. The effect of the process would be to smelt this to base metal, which would mix with, debase, and augment the gold.

These papyri contain a great variety of other recipes for gold-making. ‘Gold’ is made not only by debasing genuine gold as described above, but also by surface treatments. Thus base gold objects were heated to redness with iron sulphate, alum, and salt. These evolved sulphuric and hydrochloric acids which removed the base metals from the surface of the gold, leaving a thin layer of pure gold which, after polishing, made the whole object look like pure gold. Other recipes describe gilding.

An interesting and primitive recipe runs :—

‘To give objects of copper the appearance of gold so that neither the feel nor rubbing on the touchstone ⁷ will discover it; particularly useful for making a fine-looking ring. This is the method. Grind gold and lead to a dust fine as flour; 2 parts of lead for one of gold, then mix them and incorporate them with gum, coat the ring with this mixture and heat. This is repeated several times until the object has taken the colour. It is difficult to discover because the rubbing gives the mark of an object of gold and the heat consumes the lead ⁸ and not the gold.’

Gilding with an amalgam of mercury and gold in the modern style is also described. A number of recipes describe gums or varnishes or dye-liquors to tint metal superficially in the style of a lacquer, and numerous methods of making gold-coloured paints or inks with various yellow lacquers and pigments are described.

⁶ This word in modern Greek simply means ‘silver’; in the works of the alchemists it seems to mean a ‘white silver-like metal’.

⁷ A hard black stone on which the gold was rubbed, leaving a bright metallic streak. The colour and extent of the streak enables an expert to judge the purity of the gold.

⁸ i. e., oxidizes it to litharge, which melts and runs off.

Much attention is also given to the making of silver and 'asemos', a white alloy resembling silver. Here is a recipe for making silver⁹ :—

'Take copper which has been prepared for use and dip it in dyer's vinegar and alum and leave it to soak for three days. Then melt one *mina*¹⁰ of the copper, some Chian Earth and Cappadocian salt and flaky Alum up to six drachmæ. Smelt it carefully and it will be excellent. Add not more than 20 drachmæ of good and tested silver, which will make the whole mixture imperishable (untarnishing).'

The process is, first, a superficial cleaning of copper (the mixture of alum and vinegar is very effective). Next the copper is melted with a kind of fuller's earth and with salt and with 'flaky alum' which in the works of the alchemists is used, in some places, for a composition containing arsenic. A *careful* fusion (in order not to drive off all the arsenic) gives a white or whitish-yellow copper-arsenic alloy. By fusing this with silver a brilliant white alloy of, perhaps, 77 per cent. copper, 19 per cent. silver, and 3 per cent. arsenic would be obtained.

We find in these papyri very clear evidence that attempts to make gold and silver, sometimes genuine and sometimes fraudulent, were being carried out in Egypt before A.D. 300. We should say that these papyri were the work of alchemists were it not that their gold-making is treated as an entirely matter-of-fact and practical process. There are no hints of revelations from gods or of traditions from ancient philosophers. There is no concealing of methods under symbols and no rhapsodies about the divine character of their art. None the less these papyri are the earliest *documents* which reveal the idea of making precious metals; the methods they use, moreover, are very like those of one of the groups of early alchemists. We cannot regard these papyri as the source from which true Alchemy developed, for one of them mentions the alchemist 'Demokritos'; but they give us the valuable information that practical goldsmiths were trying to make gold and silver in Egypt not long after the time when the first alchemists were writing.

These papyri are not in the direct tradition of Alchemy. They are nowhere quoted or alluded to by an alchemical author, and they lack the spiritual aspect always present in Alchemy.

The Earliest Greek Alchemical Authors.

The truly alchemical texts of the Græco-Egyptian period include much that is earlier than A.D. 300. These early texts are attributed for the most part to lofty sources. Demokritos, Isis, Iamblichos, Moses, Ostanos, Eugenios, Maria, Kleopatra, Agathodaimon, Komarios, Hermes, Pammenes, Chymes, Pibechios, Petasios are the names we find attached to early alchemical texts. The character of these texts precludes any possibility of the attributions to the historical Demokritos, Iamblichos, Moses or Kleopatra being correct: the

⁹ *Papyrus Holmiensis* (1st recipe).

¹⁰ 1 *mina* = about 1 lb. = 100 drachmæ,

attributions to supernatural personages need not be discussed: the other authors—Eugenios, Komarios, Pammenes, Chymes, Petasios—cannot be identified with any known personage. Many of the early texts are anonymous. It seems likely that the sources of all these texts are concealed by pseudonyms: this is only to be expected in view of the secret character of early Alchemy, and also of the respect which antiquity conferred upon alchemical writers.

The Schogl of Demokritos.

The most important of these early alchemical writers was Demokritos. The style and content of the texts preclude their having been written by Demokritos of Abdera (d. 376 B.C.), but their ascription to him is readily understood, for a considerable pseudonymous literature attaches to his honoured name. The alchemical author who took the title of Demokritos wrote before A.D. 250, as is witnessed by his mention in the Stockholm and Kenyon papyri: Zosimos (third to fourth century) mentions him as an ancient author, so an ascription of his work to the second century A.D. is reasonable. His successors regard him as *The Philosopher*, inferior perhaps to Hermes in prestige, but superior in lucidity and scope. Two works attributed to him survive—the *Physical and Mystical Matters* and the *Book addressed to Leukippos*. He certainly wrote many other books, which are freely quoted by Zosimos.

The *Physical and Mystical Matters* is obviously a composite work. It opens with two very practical recipes for dyeing cloth purple; these closely resemble the recipes contained in the chemical papyri. The style then abruptly changes to one which is best characterized by quotation:—

‘ Recollecting these ideas of our ordained master and knowing the diversity of matter we endeavoured to bring the natures into harmony. But as our master died before we were initiated and at a time when we had not attained the complete knowledge of matter, we were told that we must evoke him from Hades. And as I set out to do this, I called upon him directly in these words. “ Grant me gifts, in return for that which I have accomplished for you ”, and having thus spoken, I kept silence. And as I called upon him many times, asking now how I should harmonise the natures, he told me that it was difficult to speak without the permission of the daemon. And he only said “ The books are in the temple ”. Returning to the temple I set myself to search if by chance I might gain possession of the books: for when he was alive he had said nothing of them. For he died leaving no testament, having, as some say, taken poison to separate his soul from his body; or better, as his son says, having taken poison in error. Before his death, he had intended to show the books to his son alone when he had passed his first prime. None of us knew anything about these books. As after a search we found nothing, we were most anxious to know how the substances and natures were made one and combined. As we had completed the combination of matter, and it was time for a ceremony in the temple, we made a common feast. Then as we were in the temple one of the columns suddenly opened but we saw nothing within. For neither he nor anyone had said the books

of his father were hidden there. Advancing, he led us to the column: leaning forward we saw with astonishment that nothing had escaped us except the precious formula which we found there:

"The Nature rejoices in the nature and the nature conquers the nature and the nature masters the nature."

'We were much surprised that he had summed up all his writings in so few words.

'I come ¹¹ also bringing into Egypt the treatise on Natural things so that you may raise yourselves above the curiosity of the vulgar and the confusion of matter.'

Thereafter the mystical atmosphere is dispelled and we return to the perfectly practical and sensible recipes—allied to those of the chemical papyri—by which the author proposes to make gold and silver. Similar abrupt transitions are found in many early texts, and it is difficult to resist the conclusion that practical treatises, not much unlike the chemical papyri already described, have been dressed up in these fantastical garments to gain the respect of later mystical alchemists. The rest of the book is divided into two parts, the *Chrysopæia* or book of gold-making and the *Argyropæia* or book of silver-making.

The recipes included in these are not in the least arcane in character, but are essentially practical methods of making gold-like and silver-like alloys. They are obscure, not through any intention of the author, but on account of our difficulty in identifying the materials and elucidating the technical procedure. The mystical commentator breaks in again in a later part of the text, but disappears again equally abruptly. It is very clear that the text of the *Physical and Mystical Matters* is composed of two separate parts, physical and mystical.

A reading of the Greek alchemical texts reveals that there are three others, not attributed to Demokritos, which resemble the *Physica et Mystica*, first in the character of their recipes and secondly in their ready separation into a practical content and a mystical or supernatural ascription. These are the *Work of Isis addressed to Horus*, the *Chemistry of Moses*, and the four small works attributed to Iamblichos. Thus the work attributed to Isis has a long mythological exordium followed by very practical recipes with no trace of Egyptian or other mystical symbology. The work attributed to Moses has a short prelude based on Exodus, xxxi and xxxvi, followed by wholly practical recipes. It is obviously a compilation and contains recipes taken direct from the works of Demokritos. A seventh or eighth century author refers to 'our treatise dedicated to Moses', thus affording evidence that the ascription to the Hebrew prophet was made at a very late date.

Finally the work attributed to Iamblichos also derives in part from that of Demokritos, and there is no trace of anything save the name Iamblichos which would warrant its attribution to that philosopher.

¹¹ This appears to be the beginning of the original treatise, to which some later author has added the high-flown introduction.

Zosimos (c. A.D. 300) quotes Demokritos freely, but makes no mention of Isis or Iamblichos, and in only one passage, of doubtful authenticity, speaks of Moses: it seems reasonable then to suppose that the ascriptions to the last three had not been made in the third or fourth century. The voluminous commentator Olympiodoros (fl. c. A.D. 425) makes no mention of them.

It may then be justifiable to postulate a 'DEMOCRITAN TREATISE' containing the practical recipes of the *Physical and Mystical Matters* and of the works of Isis, Iamblichos, and Moses, but not their mythological or pseudo-historical exordia and interpolations. This treatise would be a work similar to, but more elaborate than, the papyri of Leyden and Stockholm, and dealing with the same subjects, the artificial preparation of gold-like and silver-like alloys, and the dyeing of purple. This hypothetical treatise may be regarded as one source of Greek Alchemy.

Two features of early Alchemy are, however, notably absent from it. These are, first, the use of elaborate apparatus for distillation and sublimation and, secondly, the mystical content which distinguishes alchemy from mere metallurgy. Sources at least as early as that of the 'Democritan Treatise' can be found for these elements in Greek Alchemy.

The works which we have conjectured to be the *débris* of the Democritan treatise mention very few pieces of chemical apparatus. It is probable, but not certain, that distillation was known to Demokritos; sublimation was, however, certainly employed by him.

The School of Maria.

In the works of the Greek alchemists there appear for the first time the familiar apparatus employed for distillation; and in addition several types of complex apparatus, probably of the reflux type, are described.

The importance of these is best indicated by the illustrations¹² (figs. 1-3), in considering which it must be remembered that nothing whatever of the character of specifically chemical apparatus has been found in texts earlier than these, and that they show us the birth of practical chemistry. The drawings have, of course, been copied in the tenth or fifteenth century, and doubtless have been more than a little mutilated and distorted. They correspond, however, in all important respects with the descriptions in the texts.

Fig. 1 shows a flask, alembic, condenser, and receiver, and also a form of reflux apparatus. Fig. 2 shows distillation apparatus, tripod, reflux apparatus, 'handsbreadth furnace', waterbath or ash-bath. Fig. 3 shows a distillation apparatus of very modern type.

It should be remembered that the nearest thing to distillation mentioned by classical authors is the condensation of steam in a sponge (Aristotle) and the condensation of mercury on a pot-lid (Dioskorides).

¹² These and other drawings from Greek MSS. appear in Berthelot's *Introduction à l'Étude de la Chimie des Anciens et du moyen Âge*, pp. 104-172.

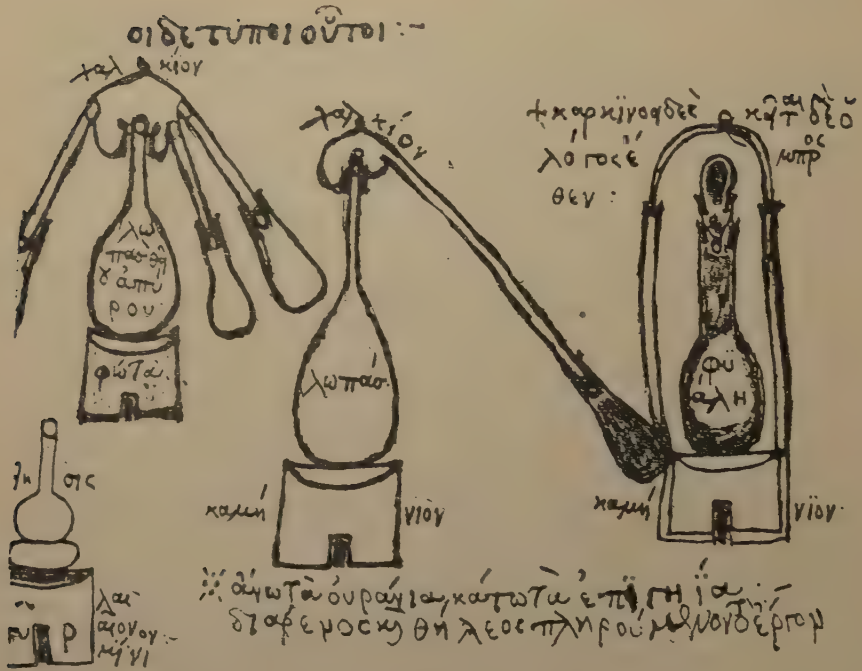


FIG. 1.—Chemical apparatus figured in MS. Parisinus 2327.

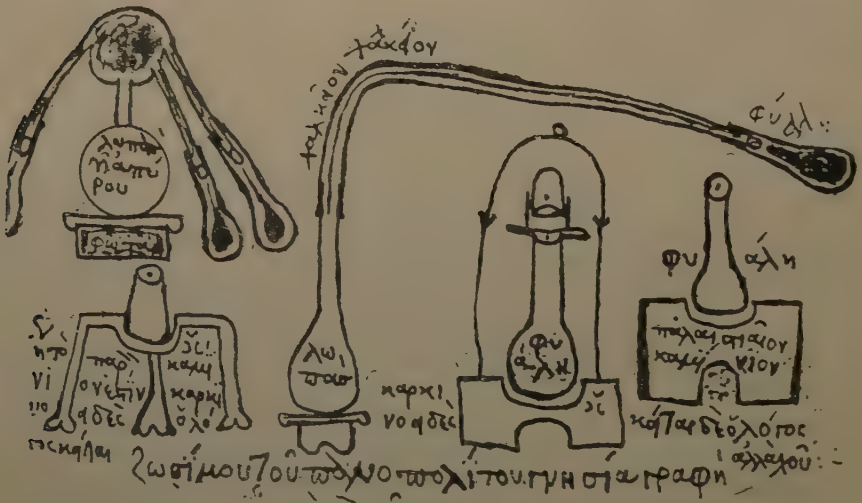


FIG. 2.—Chemical apparatus figured in MS. Parisinus 2327.

From Egypt, however, has come a doubtful hint of an earlier use of distillation apparatus. Two objects discovered at the Bucheum, close to the Egyptian town of Hermonthis, mentioned in our texts as a place where alchemy was practised, somewhat resemble still-heads, but the angle of the side-tubes suggests that they are probably enemas, or funnels used in the embalming of bulls. They may date from 200 B.C.

The *kerotakis* apparatus is peculiar to Greek Alchemy. The word means an artist's palette; the Greek painter's medium was wax, and his colours had therefore to be kept hot on a palette rather like a bricklayer's trowel. This was heated on a little stove. The *kerotakis* apparatus used by the Greek alchemists seems to have been a triangular palette on which metals were exposed to the vapours of sulphur, arsenic, or mercury. The apparatus always comprised a furnace, a place where the volatile substance was heated, a palette



FIG. 3.—Distillation apparatus, from MS. Parisinus 2327.

to support the metals and a condensing cup to condense and return the vapours. Its utility as a means of gold-making is very difficult to picture.

The passages describing all these types of apparatus are, with rare exceptions, to be found in the works of Zosimos and later commentators. It would appear that Zosimos was in the habit of using apparatus of this type, but that he did not devise it himself, and regarded the works of the Jews, especially those of Maria the Jewess, as the source of his information. He repeatedly quotes Maria's descriptions and directions. It may be noted, in passing, that in this early age of Alchemy women were prominent in the Art. Maria the Jewess, the alchemist Kleopatra, Theosebeia the sister of Zosimos, and Paphnutia the Virgin are mentioned. All four belong to the first three centuries of the Christian era.

The works of Maria are unhappily lost, but are quoted freely by Zosimos, who tells us that a great number of pieces of apparatus were devised by her, especially those of the *kerotakis* type, and also furnaces. The most extensive passage quoted by him reveals Maria as a practical chemist, and confirms our

belief that the name Maria is not a mere ascription, but is that of a real woman who knew the interior of a kitchen. Zosimos¹³ quotes her :—

‘ Make ’ she says, ‘ three tubes from ductile bronze, thin metal in thickness little more than that of a frying pan for cakes, in length a cubit and a half. Make three such tubes and make one of the diameter of about 3 inches adjusted to the opening of the copper still-head. Let the three tubes have openings adapted to their little receivers ; let there be a little nail for the thumb tube so that the two finger tubes may be adapted to the two hands from the sides. Near the edge of the copper still-head are three holes adjusted and let it be soldered to fit closely to that part which carries the vapour upwards in the contrary direction. And placing the still-head on the earthenware flask containing the sulphur and having luted the joints with flour paste, put large glass flasks on the ends of the tubes, so thick that they will not break with the heat of the water carried up the middle.’

The description corresponds closely to a pictorial representation reproduced from Marcianus 299 by Berthelot, *Introduction*, p. 139, fig. 15.

Maria was not a contemporary of Zosimos: we must therefore regard her works and ‘ the books of the Jews ’ as the source of the chemical technique appearing in these texts. It is stated in these texts that the Egyptians initiated the Jews into these alchemical secrets. Conformably to this, the only early author other than Maria who speaks of this apparatus is Agathodæmon, who writes as if from Memphis. Zosimos, moreover, writes to his sister Theosebeia, saying he has seen an ancient furnace in a temple at Memphis, and then goes on at once to quote Maria about distillation apparatus. The degree of credence to be afforded to such statements is a matter for individual judgment.

Maria was not only concerned with distillation. Her alchemical method is distinct, but most obscure, apparently being based on the treatment of copper and lead in the *kerotakis* with arsenical or sulphurous vapours. Her work had also some mystical content, her chief maxim being ‘ Join the male and the female and you will find what you seek ’. The greater part, if not the whole, of practical Greek alchemy derives from the Democritan treatises and the lost works of Maria.

The Mystical Texts

The symbolic and mystical part of alchemy seems to derive in the main from other sources.

Certain texts, we have seen, have preludes and interpolations concerned with the supernatural. These have no direct bearing on alchemical procedure, but merely indicate the lofty source of the quite mundane matter which follows. The works of Demokritos, Isis, and Moses belong to this class.

Another class of text is truly symbolic, describing what may be a practical or a mystical process in terms of symbols which cannot be given a literal interpretation. The most important of these texts are the early and fragmentary

¹³ *On the Tribikos and the tube*: Berthelot, *Collection*, p. 236.

Dialogue of Komarios and Kleopatra and *Dialogue of Kleopatra and the Philosophers*, quotations from which appear below, and the page of symbolic pictures entitled the *Chrysopaia of Kleopatra*. Somewhat similar are the remarkable text of the book of Ostanos addressed to Petasios, the texts dealing with the Serpent Ouroboros and the obscure but impressive Visions of Zosimos (pp. 88–92 of this number).

To these must be added a number of short fragments, oracles of Apollo and Orpheus, fragments of the lost works of Hermes, etc.

In connection with these texts the question must necessarily arise as to whether their content is to be interpreted as a symbolic description of human regeneration or as a symbolic description of a metallurgical process. The question can only be settled by a careful study of the texts, and no doubt the two aspects are not mutually exclusive.

The central themes of the works attributed to Kleopatra are the Unity of All Things, and Death and Revivification by a symbolic Water.

The *Chrysopaia of Kleopatra*¹⁴ indicates these notions briefly. It consists simply of a page of symbolic drawings. In the centre of the Serpent Ouroboros who eats his tail are the words 'Εν τὸ πᾶν'—'One is all'. Another emblem contains the symbols of gold, silver, and mercury enclosed in two concentric circles, within which appear the words 'One is the serpent which has its poison according to two compositions' and 'One is All and through it is All and by it is All and if you have not All, All is Nothing.' A distillation apparatus is clearly figured, and also other alchemical apparatus and symbols not clearly understood.

A quotation may show the character of the text of the *Dialogue of Kleopatra and the Philosophers* :—

'Ostanos and those with him answered and said to Kleopatra :

"In thee is concealed a strange and terrible mystery. Enlighten us, casting your light upon the elements. Tell us how the highest descends to the lowest and how the lowest rises to the highest, and how that which is in the midst approaches the highest and is united to it, and what is the element which accomplishes these things. And tell us how the blessed waters visit the corpses lying in Hades fettered and afflicted in darkness and how the medicine of Life reaches them and rouses them as if awakened by their possessors from sleep ; and how the new waters, both brought forth on the bier and coming after the light penetrate them at the beginning of their prostration and how a cloud supports them and how the cloud supporting the waters rises from the sea."

And again :—

'For I tell this to you who are wise : when you take plants, elements and stones, from their places, they appear to you to be mature. But they are not mature until the fire has tested them. When they are clothed in

¹⁴ Berthelot, *Introduction*, fig. 12.

the glory from the fire and the shining colour thereof, then rather will appear their hidden glory, their sought-for beauty, being transformed to the divine state of fusion. For they are nourished in the fire and the embryo grows little by little nourished in its mother's womb and when the appointed month approaches is not restrained from issuing forth. Such is the procedure of this worthy art. The waves and surges one after another in Hades wound them in the tomb where they lie. When the tomb is opened they issue from Hades as the babe from the womb.'

Such passages as the above may be interpreted in detail as referring to the mystical death and regeneration of the soul, and also to the destruction of metals in the interior of the kerotakis (referred to as the Hades) and their revivification in the smelting fire. In my belief, the alchemists who wrote this text saw in the practical operations a symbol of mystical regeneration and, moreover, regarded the practical process as essentially similar to the mystical, and even perhaps as having some magical effect in promoting the latter.

The texts we have just considered centre round the idea, essential to all mysticism, of death and revivification. The later Visions of Zosimos, printed on pp. 88-92 develop the same theme. These visions have something of the quality of an actual dream and are probably not merely allegories couched in dream-form. The visions can be read equally well as a mystical process for exaltation of man, or a practical alchemical process of exaltation of metals; and as the temper of the age was far more mystical than practical, we should do very ill to reject the former interpretation.

The Symbolism of the Serpent.

The tail-eating serpent who must be slain is a most interesting symbol which is found in several early alchemical texts. The symbolic use of the serpent is so universal a habit of religious thought that it gives no clue to the origin of the writings that make use of it. This symbolism dates back to the mesolithic (Azilian) culture, and almost every race has incorporated the serpent, at once wise and deadly, in its symbology. But the serpent of the alchemical text is Ouroboros, he who eats his tail. This symbol is much less common. The Gnostic text 'Pistis Sophia' describes the disc of the Sun as a great dragon with his tail in his mouth. In the same work the notion appears that the earth is encircled by such a dragon, beyond which is the outer darkness where souls incapable of redemption are cast. Again the fourth-century writer Horapollon says that the Egyptians represented the universe as a serpent devouring its tail. The same image is often found on Gnostic gems.

The dragon or serpent is also a guardian of treasure—witness the golden apples of the Hesperides. The notion of the tail-eating dragon is, then, that of the guardian of the treasure, the Sun, the universe, within which can be written the *Ἐν τῷ πᾶν*. The task of the adept or of the practical alchemist alike is to

destroy or dissolve this guardian of the treasure and use his corpse as a stepping-stone to the treasure itself ('Visions of Zosimus', see p. 90).

The imagery of the serpent is found in the early and strange texts attributed to Ostanēs, the legendary Persian instructor of Demokritos. This text is notable for a curious symbolism.

Zosimos speaks of him as 'the very ancient Ostanēs', and quotes him as follows:—'Another author speaks of a certain Sophar who formerly dwelt in Persia as saying "There dwells upon a pillar an eagle of bronze which descends into the pure spring and bathes each day, thence renewing itself".'

Again Ostanēs is quoted as saying 'Go towards the current of the Nile, you will find there a stone which has a spirit'.

The text attributed to him has the appearance of being of early date. The first paragraphs may be quoted:—

'1. The unalterable nature rejoices in a little water. For mixtures (of mercury) alter it from its underlying nature. For every disease is healed by this precious and divine water. The eyes of the blind see, the ears of the deaf hear, the dumb speak clearly.

'2. Here is the preparation of this divine water. Taking the eggs of the serpent of the oak which dwells in the month of August on the mountains of Olympus or Libanus or Taurus. Put a pound of these which must be fresh in a glass vessel. Place on them, divine water, that is hot, and raise the sulphur without fire, four times into the sky until the distillate of oil is purple. Take 13 ounces of Amianthus, 9 ounces of the blood of the murex, 5 ounces of the eggs of the golden winged hawk . . .'

The Symbolism of the Egg.

The egg very naturally plays a large part in alchemical symbology, and it would indeed have been surprising if the egg, from which the living creature so mysteriously develops, had not been adopted by Alchemy, an art essentially creative. The symbol of the egg is of great antiquity. In one of the Egyptian cosmogonies Ra was produced as an egg from sky and earth, and Ptah the great artificer shapes the sun-eggs and moon-eggs on his potter's wheel. The notion reappears in the various Orphic cosmogonies which have in common the production of an egg of light (or, in some versions, of matter) from which the God emerges. In one version the two parts of the egg become heaven and earth. In the Upaniṣads (the *Chhandogya Upaniṣad*) the cosmic egg breaks into a silver half which becomes the earth, and a golden half which becomes the sky. Various parts become the mountains, rivers, seas, etc., while from the egg itself is born the Sun. In the Greek alchemical texts there appears a rather similar notion in which the parts of the egg are assimilated to various substances. These texts seem to represent a tradition independent of those already mentioned. The notion appears in Zosimos, and the texts whose substance he seems to draw on probably therefore belong to the early

period of Greek Alchemy. The symbolism does not occur in the Democritan text nor in the fragments of the work of Maria. Thus one of these ¹⁵ texts begins :—

'The Nomenclature of the Egg : it is the mystery of the Art.

'It is said that the egg is composed of four elements because it is the image of the world and contains in itself the four elements.'

The text goes on to say that the shell represents Earth and the metals ; the white represents water, and the divine water ; the yellow of the egg is said to be chalcantum (vitriols) ; the oily part of the egg is fire.

This is, however, merely a philosophic rationalization of a primitive symbol. When Olympiodoros (fifth century) tells us that Hermes wrote of the Egg in the Pyramid : that the egg is the reproduction of the universe, and is the 'world with golden hair' we may be coming nearer to the source of this symbol.

Symbolism of Planets and Metals.

A type of symbolism which can be traced to sources much more ancient than any we have for Alchemy is the association of metals with the planets, discussed by Prof. J. R. Partington on pp. 61–64 of this number, and need receive no further notice here. It is uncertain how early such symbolism is to be found in alchemical texts. The Leyden papyrus uses the signs of Sun and Moon for gold and silver, so that a part at least of the planet-metal symbolism was in use in the late half of the third century. The apparently early text, the *Chrysopœia of Kleopatra* also shows these symbols, and it is fair to suppose that the adoption of the assimilation of the metals to the heavenly bodies is contemporary with the beginnings of alchemy itself.

Hermes as Founder of Alchemy.

The legendary founder of the Art of Alchemy is Hermes, who, however, makes but a small appearance in the Greek alchemical writings.

Hermes Trismegistos was regarded by the Greek alchemists as a remote and lofty figure. Among the alchemical texts we find only three attributed to him. One is not alchemical, but is concerned with divination. Another is doubtfully alchemical. The third is the Enigma :—

'Unless you disembody the bodies and embody those without bodies, nothing which is expected will occur.'

Several quotations from the lost works of Hermes are to be found in the works of Zosimos and Olympiodoros. They tell us very little, but indicate that his works had both mystical and practical aspects, and would perhaps suggest that they were allied to the work of Demokritos rather than that of Maria.

¹⁵ Berthelot, *Collection*, I, iv, p. 20.

The famous Emerald Table of Hermes is not found in Greek Alchemy, though its mention in an eighth-century Arabic text, and the existence of the Greek word *telesmus* in the Latin version hint at a Greek original. It may confidently be asserted that it was unknown to the Greek alchemists whose works survive. These do not quote it, and indeed its ideas and expression differ widely from anything contained in Greek alchemical texts.

The conjecture that the Emerald Table, and indeed much that was known by the Arab alchemists, was derived from an independent early source is a tempting one, though the evidence is too scanty to allow of anything more than speculation.

Numerous Independent Sources of Greek Alchemy.

All the important early texts have now been considered, and it is clear that no one of these can be regarded as the original source of the alchemical tradition. The following groups of texts appear to represent different schools of alchemical thought, and there is no reason to suppose that any one of them is earlier than the others :—

The Democritan Treatise. (Practical colouring of metals.)

The lost work of Maria. (Operations involving elaborate apparatus.)

The works attributed to Kleopatra. (Mystical.)

The work attributed to Ostanes. (Mystical and practical.)

The fragments of Hermes. (Mystical and practical.)

The Egg-symbolists. (Symbolic.)

It must be concluded that, at the date when these earliest treatises were written, Alchemy was already a well-developed system with several schools of thought. There is, however, no direct evidence in the Greek alchemical texts of any remote antiquity for the origin of Alchemy. The definite assertion of the texts, their place of origin, and the character of their mythology and symbolism indicate that their immediate source was Egyptian ; but the acceptance of the assertion that the texts are based on secret knowledge immemorially in the possession of the Egyptian priesthood must be a matter for individual judgment. If we accord even a tentative adherence to such a theory, we may be comforted by the certainty that the evidence for any other origin of Alchemy is even more slender.

AN INTRODUCTION TO THE BIBLIOGRAPHY OF ALCHEMY.—PART I.

By GERARD HEYM.

THIS introduction is intended for the student who has only a superficial knowledge of the literature of Alchemy.

The first part consists of bibliographical material that refers to the texts themselves¹. The second part will be more extensive, and will include historical works, special monographs, references in other works, sources, manuscripts and references to texts in Oriental languages.

1. *Bibliographies.*

- (1) PIERRE BOREL. *Bibliotheca Chimica.*

Paris, 1654. Reprinted Heidelberg, 1656.

(Ferguson, i, p. 116.)

This is the first printed list of titles of Alchemical books and manuscripts; it is of considerable use for the older literature. Many copies are bound with interleaved pages, which usually contain additional titles.

- (2) NICOLAS LENGLET DUFRESNOY. *Histoire de la Philosophie Hermétique.*

Paris, 1742. 3 vols.

(Ferguson, ii, p. 25.)

The bibliography is contained in vol. iii. There are more titles than in Borel. This bibliography is of use in that it shows the extent of the literature at the time of its publication.

- (3) JOHN FERGUSON. *Bibliotheca Chemica.*

Glasgow, 1906. 2 vols.

This work is indispensable for the student, being a masterpiece of bibliographical research. Besides full descriptions of Alchemical books it contains notices of books of the iatro-chemical school, early chemical books, books on metallurgy, assaying, early technology, books of secrets and early pharmaceutical books. This bibliography does not claim to be complete, but almost all the important Alchemical works are listed. There are a few omissions, such as *Fra Donato Devandro, Dell' Elixir Vitæ*, Naples, 1624, small folio, with 19 curious plates at the end, and the *Manuale Hermeticum sive Introitus Quadriforis*,

¹ Reference will be made to Ferguson, *Bibliotheca Chemica*, whenever possible,

Wolferbytum, 1655, 8vo, containing an early version of the tract attributed to St. Dunstan. Many of the German books and small tracts on Alchemy published during the 18th century are not included, but these are very often written by authors of a Theosophic persuasion and important only for the student of metaphysics.

Many books not included in the list of titles are mentioned in the bibliographical notes.

This collection of books described by Ferguson is at the disposal of students in Glasgow, where there is also another excellent collection of similar books. This was formerly in the possession of Ferguson, the author of this bibliography.

(4) WILLIAM COOPER. *A Catalogue of Chymical Books.*

London, 1675.

(Ferguson, i, p. 135.)

This list contains, according to Ferguson, some five or six hundred entries of English books solely. Cooper was the English publisher of books on Alchemy, and some of his books have lists at the end that contain titles not mentioned in his catalogue.

(5) THE LIVES OF THE ADEPTS in Alchemystical Philosophy, with a Critical Catalogue of the Books in this Science.

London, 1814.

(Ferguson, ii, p. 41.)

This book contains a list of 751 titles of Alchemical books on pp. 95-112.

A re-issue of this book by A. E. Waite appeared, London, 1888. The list of titles on pp. 276-306 contains a few new items.

(6) JOHN FERGUSON. *Some English Alchemical Books.*

Reprint of a lecture. *Journal Antiquarian Society*, vol. ii, 6.

A very scholarly treatise on English Alchemical books, with the dates of their appearance.

(7) FRIEDERICH ROTH-SCHOLTZ. *Bibliotheca Chemica.*

Nürnberg und Altdorf, 1727.

(Ferguson, ii, p. 297.)

This work is issued in five parts. It only includes names as far as those beginning with the letter 'H', and the first two parts were issued in a second edition, 1735.

Making all due allowance for the age during which this work was written, it is the only really scholarly Alchemical bibliography we have, other than that of Ferguson.

1 a. *Bibliographies that contain titles of Alchemical books.*

- (1) LADRAGUE. Bibliothèque Ouvaroff.

Moscow, 1870.

Only 75 copies printed. Contains 1883 items, some of which are repeated. A careful and erudite bibliography, including many titles of books about the pansophic societies of the 18th century. There is a copy in the British Museum.

- (2) Catalogue des livres rares et singuliers de la bibliothèque de l'abbé SEPHER.
-
- Paris, 1786.

Sale catalogue of a famous library. Contains titles of some rare Alchemical works not to be found elsewhere. Copy in the British Museum.

- (3) CAILLET. Manuel Bibliographique des Sciences Psychiques.
-
- Paris, 1913. 3 vols.

Contains many Alchemical titles, most of which, however, are taken from the catalogues of Ladrage, Sepher and de Guaita.

- (4) STANISLAS DE GUAITA. Catalogue de sa Bibliothèque.
-
- Paris, 1899.

The catalogue of an eccentric collector who was a well-known figure in Paris of the nineties. Many rare Alchemical works are mentioned, among which there are some extremely rare manuscripts.

- (5) F. LEIGH GARDNER. A Catalogue Raisonné of Works on the Occult Sciences.

Vol. i, Rosicrucian Books.

Second edition. Privately printed. London, 1923.

This catalogue is unscholarly and often inaccurate. It includes many titles of rare Alchemical works, with especial reference to the pansophic societies of the 17th and 18th centuries.

- (6) BIBLIOTHECA CHEMICO-MATHEMATICA:

London, 1921. 2 vols. and supplements.

This catalogue, compiled by Mr. H. Zeitlinger of Messrs. Sotheran & Co., London, contains many Alchemical titles, with bibliographical and scholarly notes.

- (7) AUGUST WOLFSTIEG. *Bibliographie der Freimaurerischen Literatur*.
Burg B.M. 1911 ff. 3 vols. and supplement.
Vol. ii, pp. 919-965.
Vol. ii, pp. 986-987.

The two sections of vol. ii contain Alchemical titles and names of books that refer to the pansophic societies of Europe, with especial reference to Germany. See also Index vol. under 'Alchimie'.

1 b. Catalogues.

- (1) Catalogue of the Newton Papers.

Auction sale catalogue issued by Messrs. Sotheby & Co., London.
July 13-14, 1936.

Newton's manuscript collection on Alchemy, almost all in his own handwriting, is contained in section 1.

- (2) Catalogue of the Hauser collection.

Auction sale catalogue issued by Messrs. Sotheby & Co., London.
April 16-18, 1934.

Sale catalogue of one of the most complete collections of Alchemical books. Also contains an interesting late Greek MS. on Alchemy, with symbolic coloured drawings.

- (3) Catalogue no. 439 issued by Messrs. Bernard Quaritch, Ltd., London.
London, 1930.

A very comprehensive collection of Alchemical books.

- (4) Catalogue of the library of Mrs. Atwood.

Issued by Messrs. William Tait, Belfast.
Belfast, 1911.

- (5) Catalogue issued by J. Denley, London.

London, 1826.

Contains a few titles of Alchemical books not found elsewhere.

- (6) Bibliography of the Paracelsus library of Dr. Schubert.

Issued by Messrs. W. Wesley & Son, London.
London, 1893.

- (7) Catalogue no. 91 issued by Messrs. Ludwig Rosenthal, Munich.

'Alchimie und Rosenkreuzer'.
Munich, 1894.

- (8) Catalogue no. 231 issued by Messrs. J. Scheible, Stuttgart.
Stuttgart, ca. 1897.
- (9) Catalogue no. 31 issued by Messrs. Jacques Rosenthal, Munich.
Munich, 1903.

In addition to the above, the student is also advised to inspect the catalogues of firms which deal in Alchemical books and which very often contain works that have escape notice, and are valuable for a complete bibliography of Alchemy:—

2. Collections of Alchemical Texts.

(1) THEATRUM CHEMICUM.

Strassburg, 1659–61. 6 vols.

For contents see Ferguson, vol. ii, pp. 436 ff.

Also Lenglet Dufresnoy, vol. iii, pp. 48 ff.

This collection contains 209 Alchemical texts.

Earlier editions appeared in 1602, Ursel, in 4 vols. (3 vols. according to Lenglet Dufresnoy); Strassburg, 1613, 4 vols.; a fifth vol., 1622; finally the present edition, 1659–61.

This and Manget's collection are our chief sources of texts, many of which only exist in these collections.

(2) JEAN JACQUES MANGET. *Bibliotheca Chemica Curiosa*.

Geneva, 1702. 2 vols., folio.

For contents see Ferguson, vol. ii, pp. 68 ff.

Also Lenglet Dufresnoy, vol. iii, pp. 60 ff.

For a comparison of the contents of Manget with the first four vols. of the *Theatrum Chemicum*, see Fabricius, *Bibliotheca Græca*, Hamburg, 1724, vol. xii, pp. 714 ff.

This collection contains 140 texts. It is more scholarly than the *Theatrum Chemicum*, the material being arranged in historical sequence. It actually contains more authors than the *Theatrum Chemicum* and also many texts that are not included in the latter collection, and from that point of view it is of greater value for the purposes of research.

(3) CONRAD HORLACHER. *Bibliotheca Chemico-Curiosa*.

Frankfurt, 1707.

(Ferguson, vol. i, p. 415.)

This is a 'condensation' of Manget's collection in German.

(4) GINÆCEUM CHIMICUM.

Lyon, 1679. One vol. only published.

(Ferguson, i, p. 318.)

About 20 texts. Was intended to be a continuation of the *Theatrum Chemicum*. A very rare work.

(5) MUSÆUM HERMETICUM REFORMATUM ET AMPLIFICATUM.

Frankfurt, 1677.

(Ferguson, ii, p. 119.)

An important collection of about 25 texts. The first edition, only containing 10 texts, was published at Frankfurt, 1625. The revised and enlarged edition of 1677 was reissued 1749.

An English translation of the whole work by A. E. Waite appeared in 2 vols., London, 1893.

(6) GUGLIELMO GRATOROLO. Veræ Alchemiæ Artis que Metallicæ.

Basel, 1561. In folio.

(Ferguson, i, p. 341.)

This collection contains 53 texts and is published in two parts complete in one vol.

There is a reprint of the above collection in 8vo, Basel, 1572.

(7) JEAN MAUGIN DE RICHEBOURG. Bibliothèque des Philosophes Chimiques.

Paris, 1740-1754, 4 vols.

(Ferguson, ii, p. 272.)

This collection contains 34 texts. Vol. iv is composed of two parts.

Ferguson mentions an edition of 1672-8, possibly by Salmon, who may be Dr. William Salmon, although Ferguson doubts this.

The Richebourg collection is very scarce in the complete state.

(8) WILLIAM SALMON. Medicina Practica.

London, 1692.

(Ferguson, ii, p. 318.)

The 2nd and 3rd books of this vol. contain English translations of Alchemical texts. There was a reissue with a new title-page in 1707.

Salmon was a man of scholarly tastes and wide reading. The catalogue of his library, published under the title *Bibliotheca Salmoneana*, London, 1713, is of interest.

(9) COLLECTANEA CHYMICA.

London, 1684.

(Ferguson, i, p. 169.)

This collection contains ten texts in English. The first is in Latin and English.

- (9 a) COLLECTANEA CHYMICA, being certain select Treatises on Alchemy and Hermetic Medicine.

London, 1893.

(Ferguson, i, p. 169.)

These texts are reprinted from a MS. formerly in the Hockley collection. It has two texts not in (9) but omits the last four in the older collection.

- (10) HERMETISCHES, A, B, C.

Berlin, 1778-9. 4 vols.

(Ferguson, i, p. 397.)

This collection contains 73 extracts from well-known texts. There is a reprint by Messrs. Barsdorf, Berlin.

- (11) FRIEDERICH ROTH-SCHOLTZ. Deutsches Theatrum Chemicum.

Nürnberg, 1728-32. 3 vols.

(Ferguson, ii, pp. 298 ff.).

This collection of rare texts contains much historical, biographical and bibliographical information not found elsewhere. There are 52 texts.

It is highly praised by Ferguson.

- (12) NEUE SAMMLUNG von einigen alten und sehr rar gewordenen Philosophisch und Alchymistischen SCHRIFTEN.

Frankfurt und Leipzig, 1767-70.

8vo (blank p. + viii + 462 pp. + 2 blank pp.).

Contains 12 texts, each with a separate title-page. The work is divided into two parts, and in the index to part ii there are the titles of three tracts not included in the copy before me.

This collection was intended as the continuation of (11).

The texts are all in German except the Latin poem by Figulus on p. 83, part ii.

- (13) ELIAS ASHMOLE. Theatrum Chemicum Britannicum.

London, 1652. 4°.

(Ferguson, i, p. 52, note.)

This work consists of a series of old English poems on Alchemy with notes by Ashmole. It contains engravings, and it is rarely found complete with the symbolical folding plate. The notes are very interesting, and contain information of value to the bibliographer.

Ashmole also edited another collection under the anagram James Hasolle: *Fasciculus Chemicus; or Chymicall Collections*. London, 1650. This contains Arthur Dee's texts and a translation of Espagnet's *Arcanum*.

- (14) FRIEDRICH JOSEF WILHELM SCHRÖDER. Neue Alchymistische Bibliothek.
Frankfurt und Leipzig, 1772-4. 2 vols.
(Ferguson, ii, p. 342.)

This collection contains 15 texts. Each vol. is issued in two parts.

- (15) FRIEDRICH JOSEF WILHELM SCHRÖDER. Neue Sammlung der Bibliothek
für die höhere Naturwissenschaft und Chemie.
Marburg and Leipzig, 1775-6. 2 vols.
(Ferguson, ii, p. 343, note.)

This work, which is mentioned by contemporary writers, I have not been able to see. In a continental bookseller's catalogue the contents were given as only partly Alchemical.

- (16) AURIFONTINA CHYMICA.
London, 1680.
(Ferguson, i, p. 57.)

This book contains 14 texts in English, compiled by William Cooper, the vendor and publisher of Alchemical books. At the end of the vol. there is a list of books for sale.

- (17) ARTIS AURIFERÆ.
Basel, 1610. 3 vols.
(Ferguson, i, p. 51.)

This is an important collection containing 46 texts.

Vol. i contains the two parts of the *Turba Philosophorum*, which is also reprinted in later collections. There is an English translation by A. E. Waite, London, 1914, of the *Turba*.

The first two vols. of the *Artis Auriferæ* were published at Basel, 1572, in a less complete form.

- (18) PHILIPP MORGENSTERN. *Turba Philosophorum*.
Basel, 1613. Reissued Vienna, 1750.
(Ferguson, ii, p. 106.)

This is a German translation of the first two vols. of (17).
The two editions differ slightly.

- (19) DE ALCHIMIA OPUSCULA.
Franckfurt, 1550. 4°.
(Ferguson, i, p. 19.)

In two parts. This collection consists of 9 texts in part i, and of the *Rosarium Philosophorum* in part ii. (See Ferguson, i, p. 52, note.)

(20) *PRETIOSA MARGARITA NOVELLA.*

Venice, Aldus, 1546.

(Ferguson, i, p. 115 ; and ii, p. 2.)

There are several editions of this celebrated collection. The one by Aldus mentioned above is the first. This was translated into English by A. E. Waite, London, 1894, as *The New Pearl of Great Price*. A German translation in 4° appeared in Leipzig, 1714. The edition of Basel, 1574, contains a slightly different introduction.

(21) *DOMENICO PIZIMENTI. Democrati Abderitæ de Arte Sacræ.*

Cologne, 1574.

(Ferguson, ii, p. 97, note.)

This collection is composed of the translations of the writings of Democritus, Synesius and Pelagius on Alchemy. There are also editions of 1572 and 1573, and reprints of later dates, as well as translations into French and German.

Ferguson has written an article on these translations for the Glasgow Philosophical Society.

(22) *NATHAN ALBINEUS. Bibliotheca Chemica Contracta.*

Geneva, 1653, and also Geneva, 1673.

(Ferguson, i, p. 17.)

This collection contains 7 texts, but the reprint has omitted nos. 2 and 3 and has slightly altered no. 6.

(23) *JOACHIM TANCKE. Promptuarium Alchemiæ.*

Leipzig, 1610. A second vol. appeared, Leipzig, 1614.

(Ferguson, ii, p. 427.)

This important collection contains about 40 texts in German.

(24) *SCHATZ UND KUNSTKAMMER.*

Leipzig (?). 2 vols.

(Ferguson, ii, p. 329 ; and ii, p. 428, note.)

This is a partial reprint of (23). I have only seen vol. ii, which had no date of publication.

(25) *SALOMON TRISMOSIN. Aureum Vellus.*

Rorschach, 1599.

(Ferguson, ii, p. 469.)

This is an early German collection of important Alchemical texts. The edition before me differs from the one mentioned by Ferguson of 1598 in that it contains additional texts at the end.

(26) ERÖFFNETE GEHEIMNISSE DES STEINS DER WEISEN.

Hamburg, 1708-18.
(Ferguson, i, p. 246.)

This collection contains 52 texts. The first 3 parts are a reprint of (25).

(27) FÜNF CURIEUSE CHYMISCHE TRACTÄTLEIN.

Frankfurt und Leipzig, 1767.
(Ferguson, i, p. 296.)

(28) MICHAEL MAIER. Tripus Aureus.

Frankfurt, 1618. 4°.
(Ferguson, ii, p. 66.)

This collection contains 3 texts. It was reprinted in *Museum Hermeticum Reformatum*. For details see J. B. Craven, Count Michael Maier, Kirkwall, 1910, pp. 94-5.

(29) ARS CHEMICA.

Strassburg, 1566.
(Ferguson, i, p. 49.)

In the copy before me the Index gives the titles of 4 texts, but there are actually only three in the volume.

(30) MANUALE HERMETICUM.

Wolferbytum, 1655.

The full title of this collection is *Manuale Hermeticum sive Introitus Quadriforis*. It contains 5 texts, among them one attributed to St. Dunstan.

This is an extremely rare work which has escaped bibliographers, although the texts exist in other collections.

(31) OPUSCULA QUÆDAM CHEMICA.

Frankfurt, 1614.
This collection contains 7 texts.

(32) J. A. FABRICIUS. Bibliotheca Græca.

Hamburg, 1790 ff.
Vol. viii, p. 119 ff., contains the Greek Alchemical poem of Heliodorus, *De Chrysopæia*.

(33) GUNTHER GOLDSCHMIDT. Heliodori Carmina Quattuor.

Giessen, 1923.

This work consists of the text of the poems of Heliodorus and a learned preface.

- (34) J. L. IDELER. *Physici et Chemici græci Minores*.
 Berlin, 1841.
 Contains an Alchemical text attributed to Stephanos.
- (35) CATALOGUE DES MANUSCRITS ALCHIMIQUES GRECS.
 Brussels, 1924 ff.
 Vols. iii, v, vi, and vii contain important texts, excerpts and translations, including a work by Michel Psellus.
- (36) MARCELLIN BERTHELOT.
Collection des Anciens Alchimistes Grecques.
 Paris, 1887-8.
 Invaluable collection of the Greek Alchemists edited from the MSS.
- (37) MARCELLIN BERTHELOT.
La Chimie au Moyen Âge.
 Paris, 1893. 3 vols.
 Vols. ii and iii contain texts and translations of Syrian and Arabian Alchemists.
- (38) COLLECTANEA HERMETICA.
 London, 1893 ff.
 A series of separate reprints of old English translations of Alchemical texts under the editorship of Wynn Westcott. There are about 5 texts.

3. *Alchemical Lexicons.*

- (1) LEONHART THURNEISSER. *Onomasticum und Interpretatio... Das Ander theil*.
 Berlin, 1583. Folio.
 (Ferguson, ii, p. 454, note.)
 The first part of this lexicon is extremely rare. I have not been able to see it, but it is described by Sudhoff in his *Bibliographia Paracelsica*, 1894.
- (2) MARTIN RULAND. *Lexicon Alchemiæ*.
 Frankfurt, 1612.
 (Ferguson, ii, p. 302.)
 This is the best Alchemical lexicon. There is an English translation issued in 25 copies only and extremely scarce. A copy is mentioned in the catalogue of the Hauser sale.

- (3) GERHARD DORN. *Dictionarium Paracelsi*.
Frankfurt, 1583.
(Ferguson, i, p. 222, note.)
- (4) J. F. A New Light of Alchymy : . . . Also a Chymical Dictionary.
London, 1674.
(Ferguson, i, p. 257.)
This lexicon is to some extent based upon (3).
- (5) WILLIAM JOHNSON. *Lexicon Chymicum*.
London, 1652-3.
(Ferguson, i, p. 439.)
This lexicon is reprinted in Manget's collection. Besides the edition of 1652-3 there are later reprints.
The lexicon is composed of two parts. Sometimes only the first part is met with.
- (6) JEAN MAUGIN DE RICHEBOURG. *Bibliothèque des Philosophes Chimiques*.
Paris, 1740-54. 4 vols.
(Ferguson, ii, p. 272.)
Vol. iv, p. 570, contains a short 'dictionnaire'.
- (7) *DICTIONNAIRE HERMETIQUE*.
Paris, 1695.
(Ferguson, i, p. 210.)
- (8) ANTOINE-JOSEPH PERNETY. *Dictionnaire Mytho-Hermétique*.
Paris, 1758.
(Ferguson, ii, p. 181.)
There is a reprint, Paris, 1787.
- (9) OSWALD WIRTH. *Le Grand Livre de la Nature*.
Paris, 1910.
On pp. 75-88 there is a lexicon of Alchemical terms.
- (10) JOHANN HELFRICH JUNGKEN. *Lexicon Chymico-Pharmaceuticum*.
Nuremberg, 1729.
(Ferguson, i, p. 445.)
- (11) ERNST DARMSTAEDTER. *Die Alchimie des Geber*.
Berlin, 1922.
On pp. 185-94 there is a short lexicon of Alchemical 'expressions', with especial reference to the writings of Geber.

- (12) ERICH BISCHOFF. *Der Sieg der Alchimie.*

Berlin, 1925.

At the end of this book there is a section devoted to 'Alchymistische Kunstaussdrücke'.

4. *Alchemical Symbols.*

- (1) DR. LÜDY. *Alchemistische und Chemische Zeichen.*

Stuttgart, 1928.

A very comprehensive and scholarly work.

- (2) G. W. GESSMANN. *Die Geheimsymbole der Chemie und Medicin.*

Munich, 1900.

This work is on somewhat different lines than that of Lüdy. It is scholarly, and emphasises the neo-platonic aspect of Alchemy. On pp. 23 ff. it contains an Alchemical lexicon.

- (3) *Medicinisch-, Chymisch- und Alchemistisches ORACULUM.*

Ulm, 1783.

(Ferguson, iii, p. 84.)

Interesting old work on symbols. The author of (2) has used this book as his source.

- (4) JOHANN JACOB BECHER. *Tripus Hermeticus Fatidicus.*

Nuremberg and Altdorf, 1719.

(Ferguson, i, p. 88, note.)

On p. 28 there is a table of symbols with their meaning, and a folding plate containing symbols on p. 41.

- (5) *CATALOGUE DES MANUSCRITS ALCHIMIQUES GRECS.* Vol. viii.

Brussels, 1932.

This vol. contains the excellent work on Greek Alchemical signs with explanations by C. O. Zuretti. Photographic facsimiles of the Greek MSS. are given at the end.

- (6) ANNIBAL BARLET. *Le vray et méthodique Cours de la Physique resoluteive, vulgairement dite Chymie.*

Paris, 1653.

(Ferguson, i, p. 72.)

On p. 180 *a* there is a table of symbols, with their meanings on the opposite page.

REPORT OF DISCUSSION UPON CHEMICAL AND ALCHEMICAL SYMBOLISM.

THE ORIGINS OF THE PLANETARY SYMBOLS FOR THE METALS.

By J. R. PARTINGTON, M.B.E., D.Sc.

THE association of certain planetary gods with metals and other materials goes back to early Babylonian times, and is, perhaps, even of Sumerian origin. Ellil, the god of Nippur, is called 'master of gold', etc., and in a text of the Cassite Period (1600-1400 B.C.), containing a magic tablet from Nippur, 'not to be shown to the uninitiated', with sixty symbols and their divine implications, silver is associated with the Moon, gold with the Sun, lead with Ninmah, and copper with Ea. The association of metals with planets is also revealed in so-called Foundation Deposits, known from 2000 B.C., if not earlier, and found also in Egypt, Nubia, and the Sudan. The best known of these is the one found at Khorsabad, under a building of Sargon II (710 B.C.), the contents of which were analysed by Berthelot. The relations of planetary gods with specific materials, referred by Hellenistic authors to the Egyptian Hermes-*Thoth*, is probably of Babylonian origin ¹.

The association of the seven planets with metals appears in the 'ladder of Mithra' reported by Origen, and an important Persian (Iranian) component seems to have fused with the Babylonian at some ill-defined date.

Origen ² quotes Celsus as follows :—

'Celsus, wishing to display his learning in his treatise against us, quotes also certain Persian mysteries, where he says: "These things are obscurely hinted at in the accounts of the Persians and especially in the mysteries of Mithras, which are celebrated amongst them. For in the latter there is a representation of the two heavenly revolutions, namely, of the movement of the fixed stars and of that which takes place among the planets, and the passage of the soul through these. The representation is of the following nature. There is a ladder with seven steps (*κλίμαξ ἑπτάπυλος*) and on the top of it an eighth step. The first step consists of lead, the second of tin, the third of copper, the fourth of iron, the fifth of mixed metal (*κεραστοῦ νομίματος*), the sixth of silver, and the seventh of gold. The first gate they assign to Kronos, indicating by lead the slowness of this star; the second to Aphrodite, comparing her with the splendour and softness of tin; the third to Zeus, being firm and solid;

¹ Full literature for the early period in Partington, *Origins and Development of Applied Chemistry*, London, 1935, 277 ff.

² *Contra Celsum*, vi, 22; Origenes Werke, edit. Koetschau, Leipzig, 1899, ii, 92; transl. in *Ante-Nicene Library*, xxiii, 360; Lobeck, *Aglaophamus*, Königsberg, 1829, 932; Bousset, *Archiv für Religionswissenschaft*, iv, 165, 237; Cumont, *Les Mystères de Mithra*, 1913, 122, 145; Cook, *Zeus*, Cambridge, 1925, ii, 129.

the fourth to Hermes, for both Hermes and iron are fit to endure all things and are money-making and laborious ; the fifth to Ares, because being composed of a mixture of metals it is varied and unequal ; the sixth of silver to the Moon ; and the seventh of gold to the Sun, these imitating the colours of the two latter ”.

Another account is that in the late Persian work the *Bundahishn*, in which the limbs of the Primeval Man, Gayomard, are related to metals and other materials ³.

Neoplatonic authors are very familiar with the idea, which expressed their view that the metals, formed inside the earth by the actions of rays from the seven planets, were part of the cosmos and were linked in its scheme of universal sympathetic influence. The lists vary somewhat, but nearly all agree in the equations : Sun = gold, Moon = silver, Saturn = lead (curiously not Venus = copper).

The literature on this subject is very large, but the following table summarises some of the more important references.

TABLE OF THE ASSOCIATION OF METALS AND PLANETS.

<i>Saturn.</i>	<i>Jupiter.</i>	<i>Mars.</i>	<i>Sun.</i>	<i>Venus.</i>	<i>Mercury.</i>	<i>Moon.</i>
1. a metal ?	—	—	gold	lead	—	silver
2. —	—	—	gold	copper	—	silver
3. lead	bronze	mixed metal	gold	tin	iron	silver
4. lead	tin	iron	gold	copper	electrum *	silver
5. lead	electrum	iron	gold	copper	tin	silver
6. —	—	—	gold	—	—	silver
7. lead	electrum †	iron	gold	copper	tin	silver
8. iron	electrum	bronze	gold	tin	lead	silver
9. lead	iron	mixed metal	gold	bronze	tin	silver
10. lead	tin	iron	gold	copper ‡	mercury	silver
11. lead	—	—	gold	bronze	tin	silver
12. lead	bronze	iron	gold	tin	copper	silver
13. lead	tin	iron	gold	copper	mercury	silver
14. lead	tin	iron	gold	copper	mercury	silver
15. lead	brass	iron	—	—	electrum	silver
16. lead	tin	iron	gold	copper	electrum *	silver
17. lead	tin	iron	gold	copper	?	silver
18. lead	tin	iron	gold	copper	mercury	silver
19. lead	silver	iron	gold	tin	bronze	crystal
20. copper	gold	iron	electrum	tin	lead	silver
21. lead	tin	iron	gold	copper	mercury	silver
22. lead	tin	iron	gold	copper §	electrum	silver

* or mercury ; † or mixed metal ; ‡ or bronze ; § or brass.

³ Partington, *Origins*, 397, 417.

[REFERENCES TO TABLE.]

1. Babylonian list of Cassite Period (1600–1400 B.C.), Langdon, *Babylonian Liturgies and Psalms*, University of Pennsylvania, University Museum, Publications of Babylonian Section, vol. x, no. 4, Philadelphia, 1919; the names of planetary gods have been equated according to the usual scheme.
2. Babylonian list given by Virolleaud, q. by Jeremias, *Handbuch der altorientalischen Geisteskultur*, Leipzig, 1913, 86.
3. Mithraic list of Celsus (150 A.D.) quoted by Origen, *Contra Celsum*, vi, 22.
4. Vettius Valens, 2nd cent. A.D., q. by Roscher and Boll, *Roscher's Lex.*, iii, 2534; about the same time Ptolemaios connected the metals with the planets 'according to their colours', Bouché Leclercq, *L'Astrologie grecque*, 1899, 313 f.
5. Alexandrian scholium on Pindar's Isthmian Odes, quoted by Lobeck, *Aglaophamus*, 936, Jeremias, *op. cit.*, 88; v. Lippmann, *Alchemie*, 1919, 216, has confused this list with our No. 6.
6. Eustathios's commentary on Homer's *Iliad*, quoted incompletely by Lobeck, 936, and in full by Fabricius, *Bibliotheca Græca*, Hamburg, 1714, vi, 809: Eustathios says gold = Sun, silver = Moon, 'and the other metals are put for the other planets'. Didymos, shortly before the Christian era, puts Mars as the 'Star of iron', Berthelot, *Introduction*, 77.
7. Olympiodoros (6th cent.) quoting Proklos (5th cent.); Fabricius, *op. cit.*; Taylor, *Two Treatises of Proclus*, London, 1833, 108; Bouché Leclercq, 316.
8. Bede (673–735) quoted by U. F. Kopp, *Palæographica Critica*, 1817–29, iii, 347 f.
- 9–11. Lists quoted by Kopp, *op. cit.*, from DuCange.
- 12–13. Lists given by Kircher, *Œdipus Ægyptiacus*, Rome, 1652–3, from various sources, some Arabic, of different dates.
14. Stephanos of Alexandria (7th cent.), Berthelot, *Introduction*, 84, 294; Lobeck, 936 f. says the relation is due in the first place to Zosimos.
15. The 'Lapidary of Aristotle', Ruska, *Griechische Planetendarstellungen in arabischen Steinbüchern*, Heidelberg, 1919, 20.
16. The Syriac *Causa Causarum* (11th–12th cent.), transl. by Kayser, 1893, 248, 284, 348.
17. Šābian accounts in Chwolson, *Sabier*, Petersburg, 1856, 839; Dimishqi, transl. Mehren, Copenhagen, 1874, 53, 71; Wiedemann, *Sitzb. phys.-med. Soc. Erlangen*, 1911, xlv, 81; Hommel, *Z. angew. Chem.*, 1912, xxv, 100.
18. An Arabic list given by Jeremias, 88; the same list in Stitt, 'Notes on some Maldivian Talismans', *J. Roy. Asiat. Soc.*, 1906, 121 f. Perhaps from Cabbalistic sources?
19. Konstantinos Manasses (1150 A.D.) q. by Cook, *Zeus*, Cambridge, 1914, i, 625, and Fabricius, *op. cit.*
20. A list quoted by Cook, *Zeus*, i, 626, from Cramer.
21. Cornelius Agrippa, q. by Forke, *World Concept of the Chinese*, 1925, 249, and in a German-Swiss astrological MS. of c. 1400, where iron is 'Stachel' (steel), Siegerist, *Archiv für Geschichte der Medizin*, 1925, xvii, 229.
22. A Syriac work on astrology translated by Budge, *Syriac Medicine*, 1913, ii, 574.

The origin of the planetary symbols, which were adopted by the alchemists as those of the metals, has been discussed since the sixteenth century. Scaliger⁴ gave the common, 'mythological', interpretation, in which we have the 'scythe of Saturn', 'the spear and shield of Mars', 'the looking-glass of Venus',

⁴ Quoted by Goguet, *Origine des lois etc.*, Paris, 1809, ii, 370.

etc. A more rational interpretation was offered by Salmasius⁵, who traced in old Greek manuscripts in Paris the derivation of the symbols of the five planets (those of the Sun, ☉, ☿, and ☿, and Moon, ☾, being mere symbols of ancient origin) as contractions of the Greek names, sometimes unusual Greek names, of the planets. Thus, from Κρ, the first two letters of the Greek name Κρόνος for Saturn, the symbol ♄ is easily derived; the symbol of Mars, ♂, from θούρας; that of Venus, ♀, from the Greek-Egyptian name Φωσφόρος; and that of Mercury, ☿, from the Babylonian-Greek Στλβων.

SYMBOLS IN GREEK ALCHEMICAL WRITINGS.

By F. SHERWOOD TAYLOR, Ph.D., M.A., B.Sc.

The Symbolism in alchemy and early chemistry assumes two divergent characters, that of a notation designed to convey in shortened form an exactly defined meaning, and that of a true symbolism designed to express pictorially or allegorically matters which could be otherwise expressed only at tedious length or not at all. Symbolic pictures of the latter type exist in Alexandrian Alchemy only in simple form, and the *Chrysopæia of Kleopatra* is the only example of a more elaborate pictorial symbol.

In the majority of the Greek alchemical manuscripts there appears a text containing a list of alchemical symbols¹ which bear a certain likeness to our modern chemical symbols. These lists are not very early (perhaps seventh century, but not later); but since the signs for gold and silver appear in the Leyden papyrus (c. A.D. 250), and other signs appear also in the *Chrysopæia of Kleopatra* (which would seem to be as early an alchemical text as any we have), the use of these signs may date back to the beginning of Western Alchemy.

The list in Marcianus 299 appears to be the oldest we have, but not the most complete: that in Parisinus 2327 contains one or two words not in use before the seventh or eighth century: it also contains signs for *materia medica*, including drugs which are not mentioned in alchemical texts. It appears that this list affords the earliest examples of symbols for *materia medica*.

⁵ *Plinianæ exercitationes*, Utrecht, 1689 872 f.; Kopp, *op. cit.*, iii, 341; Weinberger, *Pauly-Wissowa, R. E.*, xi, 2217; Bezold, Boll, and Gundel, *Sternglaube und Sterndeutung*, Leipzig, 1931, 119, 130, 211.

¹ The lists from Marcianus 299 and Parisinus 2327 are reproduced in Berthelot's *Introduction à l'Etude de la Chimie des Anciens et du moyen Âge*, pp. 104-20, from which figs. 1 and 2 have been taken. Of still greater value is the work of C. O. Zuretti, *Catalogue des Manuscrits Alchimiques Grecs*. viii. *Alchemistica Signa* (Brussels, 1932), wherein the alchemical signs from a large number of Greek MSS. are listed, described, and in part reproduced in facsimile.

These signs are derived from three sources :—

- (a) From planetary signs of metals, to which various modifications are appended.
- (b) From pictorial representations of the thing symbolized.
- (c) From the letters of the name of the thing symbolized.

(a) Professor Partington has (pp. 61–64) discussed the planetary signs. The use of some of these for the metals has been prevalent throughout the whole course of Alchemy. The Alexandrian alchemists, however, appended to these signs various suffixes which indicated modifications of the metals.

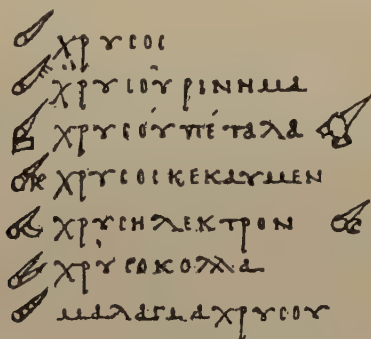


FIG. 1.—Signs for modification of gold. (Marcianus 299.)

Thus the seven signs, reproduced in fig. 1, represent :—

- (1) Gold.
- (2) Gold filings.
- (3) Gold leaf.
- (4) Calcined Gold.
- (5) Electrum. (Sign of gold and silver combined.)
- (6) Chrysocolla. Solder of Gold. (Two gold signs joined.)
- (7) *Malagma* of Gold. (Mixture of gold.)

The notation for the alloy electrum, arrived at by combining the signs of gold and silver, its constituents, contains the germ of modern chemical symbolism though, of course, the distinction between mixtures and compounds was as yet unmade.

(b) The signs for a few substances were pictorial. Thus the signs for *eggs*, for *eye*, for *rain-water*, and *sea-water* (fig. 2) are representations of the thing itself. Very few chemical materials can be represented pictorially; consequently this type of symbol is but little employed.

(c) The commonest method of constructing a sign was from the letters of the name of the substance denoted.

Thus the sign (fig. 2) for Chalkanthos—flowers of copper, actually a mixture of copper and iron sulphates—is composed of the letters χ and θ , while the sign for ochra is made up of the letters χ and \omicron . This practice shows a further approach to our modern chemical symbolism, in that it is clearly not intended for purposes of secrecy, but merely of brevity.

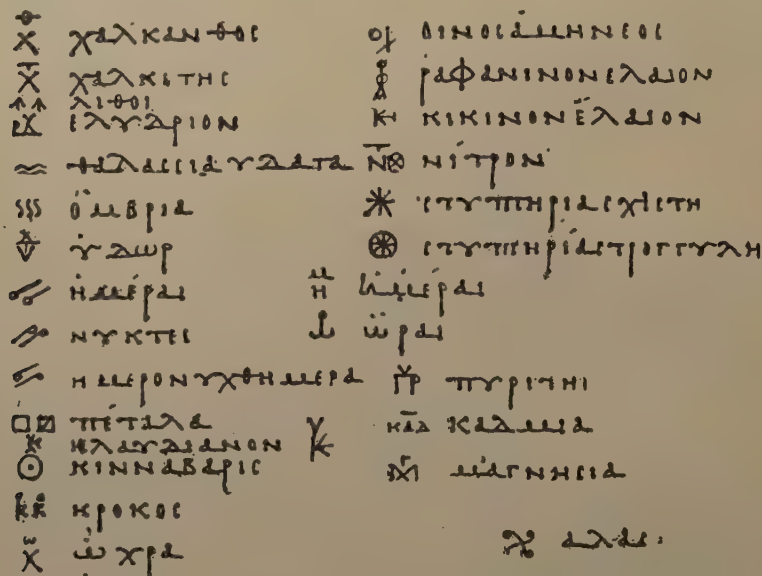


FIG. 2.—Signs from the MS. Marcianus 299.

(d) There remain a number of signs, the connection of which with the substance symbolized remains doubtful. Examples are to be found in the signs for

Στυπτηρίu σχιστή, flaky alum,

Στυπτηρία στρογγύλη, round alum.

The star (fig. 2) may represent a crystalline efflorescence.

The sign for cinnabar, a circle with a dot in the centre, seems obscure; in later ages it was used to represent gold.

It is interesting to note that this system did not pass into Western Alchemy without the widest alteration.

A Syriac manuscript in the British Museum has a list of alchemical signs, among which the signs for Iron, Lead, Elydrium, Water, Glass, Flaky Alum, Earth, Chrysocolla are nearly identical with the Greek signs, while the remainder are much changed or totally different. This MS shows direct contact with

Greek Alchemy, for Greek words have simply been transliterated into Syriac. In spite of this the Greek signs have not in general been retained.

F. Lüdy has produced under the title *Alchemistische und Chemische Zeichen* (Stuttgart, 1928) a valuable list of the alchemical and medical signs used in Western Europe. There appears to be little connection between the Greek and Western usage, save that which follows from the use of planetary symbols and of initial letters.

In fact, about half a dozen of the Greek symbols have found their way into Western alchemical practice. These represent but the smallest proportion of the signs actually in use, hundreds being employed both in Greek and in Western alchemy.

The question remains as to how far these signs were the exclusive property of Alchemy. Their association with *materia medica* indicates that the symbolizing of substances was in use in pharmacology at an early date. The signs for gold and silver appearing in the Leyden papyrus, which seems to have been a craftsman's notebook rather than an alchemical text, also suggests that these abbreviations were known to others beside alchemists.

THE MACROCOSM AND THE MICROCOSM IN MEDIÆVAL ALCHEMY.

By A. F. TITLEY, B.Sc., D.Phil.

[PLATES I-IV.]

Alchemical literature of Europe in the mediæval and post-Renaissance periods is characterized by the complexity and obscurity of its symbolism. The previous Islamic writers transmitted to some extent the gnostic and neo-Platonic ideas of Greek Alchemy, but did not elaborate a symbolism. This may have been partly due to the Moslem ban on the human form in Art and decoration, a ban which did not exist to check the play of anthropomorphic fancy in Christian Europe.

The purpose and aim of these complex symbolic and allegorical illustrations no doubt varied widely; some seem to have been purely fanciful, some were a portentous cloak for ignorance, some guarded representations of imagined theoretical or genuine practical knowledge. Apart from motive, however, an interesting question is how far their form was novel and how far it was determined by the scientific traditions and environment in which Alchemy took root about the year 1200. The chief comprehensive theory which, at that date, had already been in vogue for many generations, in philosophical, medical, and astrological circles, was that of the Macrocosm and the Microcosm,

a theory which, up to and even after the Renaissance, occupied a position comparable to the Theory of Evolution in our own time. Briefly, it was the assumption that the *Macrocosm*—that is the outer universe, the great system of the Sun and the stars, the winds and the elements—obeyed the same laws as those operative in the *Microcosm*—variously conceived, sometimes as the body and soul of Man, sometimes as the terrestrial sphere, sometimes as other entities. As a corollary, some species of sympathetic influence was conceived of as existing between events in the Macrocosm and in the Microcosm. The best known and only surviving aspect of this doctrine is, of course, the lingering popular belief in astrology.

The complexities of the theory were singularly well suited to exposition by symbolism. Good examples are to be found in the symbolic drawings of Hildegard of Bingen, which have been fully described by Professor Charles Singer (*Studies in the History and Method of Science*, vol. i). These are especially interesting because they were executed between 1150 and 1200, that is just prior to the penetration of Alchemy into Western Europe from Arabic Spain. Pl. I shows Celestial (*i. e.* Macrocosmic) influence on the human Microcosm, Pl. II Celestial influences on men, animals, and plants, the Microcosm in this case being the World.

It was impossible that the new science of Alchemy should avoid this established way of thought, and one of the first cares of alchemical theorists was to devise a suitable macrocosmic-microcosmic scheme for their science. Eventually these often attained to a high degree of elaboration. With Pls. I & II we may compare Pl. III from the *Basilica Chemica* of 1618, showing the Celestial, Planetary, and Zodiacal Worlds surrounding the Alchemical World, and Pl. IV, showing the seven planets radiating their influence on the earth and favouring the generation of metals, while the hypostatical principles also radiate 'emanations' (from an eighteenth century MS. reproduced in Professor Read's *Prelude to Chemistry*).

The scheme offered great scope for individual theorizing because, while there was one macrocosm only, there might be postulated a variety of microcosms. The interior of the earth could form a microcosm of its own, with metals and minerals germinating instead of flowers and trees, with rivers of lava flowing instead of rivers of water, and where subtle gnomes or elves moved in an atmosphere of solid earth in place of solid men moving in a subtle atmosphere of air. This last belief is unquestioned by Paracelsus in the sixteenth century, and was familiar to Boyle in the seventeenth.

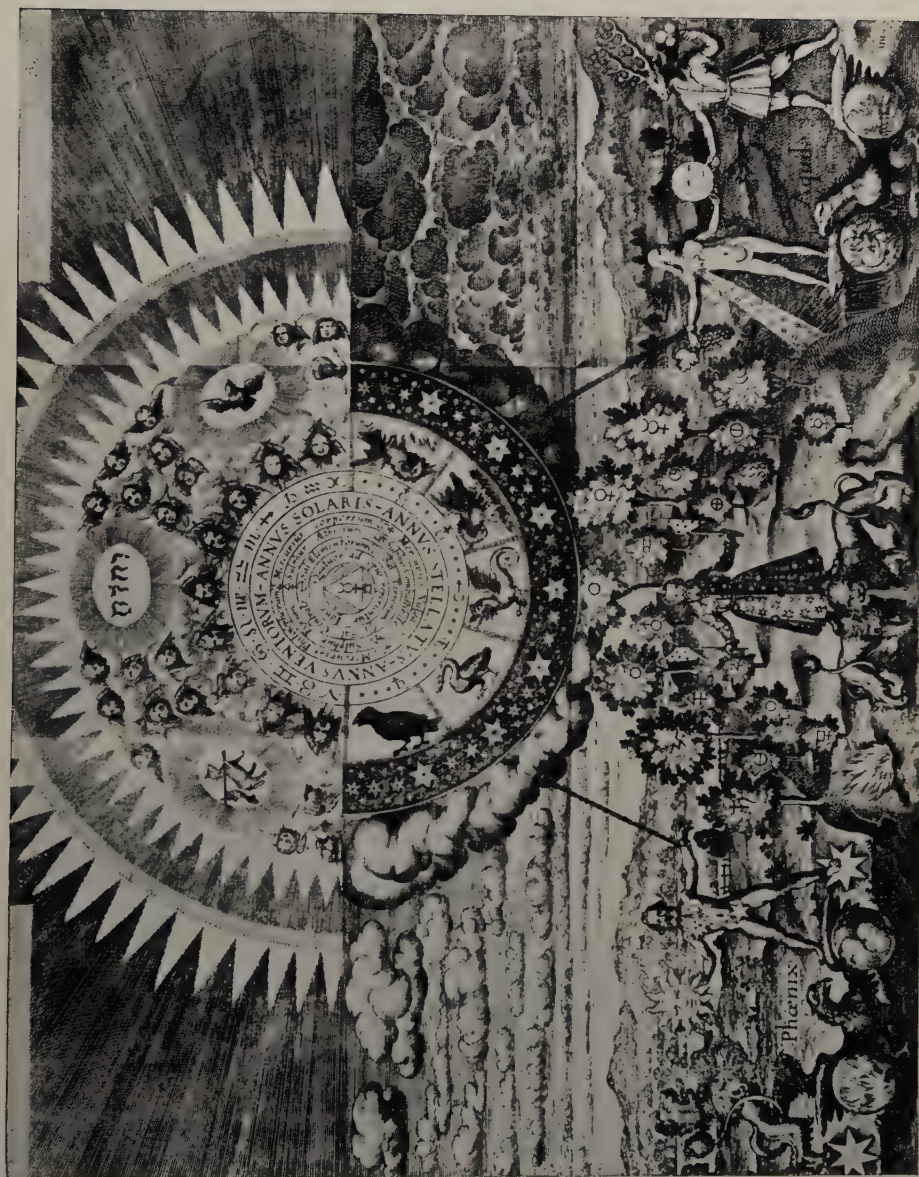
Then again the Microcosm was sometimes conceived as the alchemist's furnace or his retort, as the Vase of Hermes or 'Philosopher's Egg', an oval glass vessel which could be hermetically sealed. It may be noted that the symbolizing of the Microcosm as an egg was a long-standing tradition pre-dating Western Alchemy, and may to some extent have determined the form taken by alchemical apparatus,



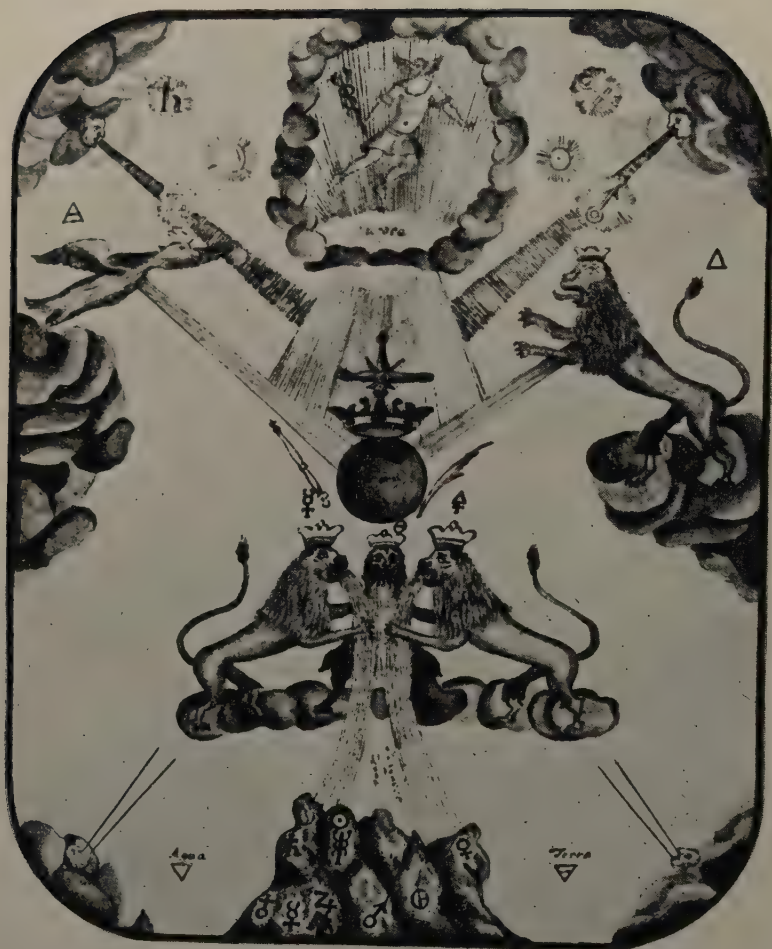
The Macrocosm, the Microcosm and the Winds. (From the *Liber Divinorum Operum Simplicis Hominis*, Lucca Municipal Library MS. fo. 27 v.; by kind permission of Professor Charles Singer.)



Celestial Influences on Men, Animals and Plants.
(*Ibid.*, fo. 371; also by kind permission of Professor Charles Singer.)



The Macrocosm and the Alchemical Microcosm. (From *Musæum Hermeticum*, 1678; reproduced by kind permission of Messrs. G. Bell & Sons and Prof. J. Read from the latter's *Prelude to Chemistry*.)



The Generation of the Metals. (From an 18th-century German MS. in the St. Andrews collection; reproduced by kind permission of Messrs. G. Bell & Sons and Prof. J. Read from the latter's *Prelude to Chemistry*, 1936.)

Finally, the microcosmic concept was applied to the experimental substance itself—the metal or lump of ore. ‘ There is another firmament in this place ’, says Paracelsus, ‘ namely, the matter contained in the glass ’, and it was often believed that the Stone would contain a central fire, would be, in fact, a perfect microcosm, corresponding to a heliocentric macrocosm.

Obviously, therefore, in attempting to interpret mediæval alchemical symbolism, due attention must be paid to the general philosophic background and the consequent absorption with relating Alchemy to a cosmic scheme.

SOME ALCHEMICAL PICTURE BOOKS.

By GERARD HEYM.

The study of the symbolical engravings and woodcuts that are found in so many Alchemical works has been sadly neglected by intelligent investigators. And yet it is in these pictures that we may hope to discover a key to the mentality of former centuries which delighted in the use of symbols and applied them to the every-day facts of life, to religion and to science. In European civilization a language of symbolism seems to have existed at the same time as that of the written word, beginning with the miniatures in the early manuscripts and the ornaments on the cathedrals, and coming into full flower in the great religious paintings of the Renaissance. No other civilization, except perhaps the Egyptian, has made such a consecutive use of symbolism even in its religious art, where we find symbolic schemes worked out in great detail, which accustomed the eye to shades of meaning completely overlooked today.

When printing had been established for about half a century a whole literature of symbolical picture-books appeared that lasted almost two hundred years. It began with Alciati's book of Emblems, which was published in 1522 in Milan and was reissued in 1534 in Paris. The book consisted of pictures expressing a moral fable or allegory which was described below on the same page by a clever epigram or in a few lines of verse. This literary convention soon took Europe by storm, for there are 1300 authors who published over 3000 books that consisted exclusively of these symbolical pictures with a short text¹, although very often this was omitted. The emblematic literature comprised not only works of moral guidance, but was also extended to religious problems, especially to those of a devotional nature², to political questions of the day,

¹ Henry Green, *Andrea Alciati and his Book of Emblems*, London, 1872.

² The *Emblems* of Francis Quarles is an instance of religious emblematic literature.

to mythology, to zoology and even to the sciences of medicine and chemistry. It is the latter subject and its connection with this type of literature that concerns us here, but it must not be forgotten that chemistry at that time was still highly speculative, and that in this philosophic phase, which is called Alchemy, it easily lent itself to a purely symbolical interpretation.

Therefore it can be assumed that those who designed and published the symbolical pictures and illustrations which are found in Alchemical books were merely observing a practice peculiar to the European mind of past centuries. Only in a few North Indian and Tibetan manuscripts, where references to Alchemy are made, is a similar use of elaborate and detailed symbolism discovered; Greek Alchemical manuscripts very often contain symbolic pictures, but these are crude and usually follow one scheme, based on the ancient astral interpretation of the forces of nature.

The pictures and illustrations in the Alchemical books are derived on the one hand from the miniatures and drawings contained in the manuscripts that existed before the invention of printing. Reference may be made here to the *Pretiosa Margarita Novella*, first published by Aldus³, to the *Janitor Pansophus*⁴, which has plates strongly reminiscent of early mediæval cosmologies, to the work called *Splendor Solis*⁵, to the *Cabala*, *Spiegel der Kunst und Natur*⁶, and to certain other works⁷. On the other hand, these books also contain plates depicting symbolical scenes in the best 17th century manner. In this case the symbolism is highly intricate—'every line and figure has meaning'; thus a contemporary author describes these pictures, a fact which is well worth remembering. Often the engraving or woodcut is of considerable artistic merit. But none of these books follow the design of the 'emblem'-book begun by Alciati.

However, in the literature of European Alchemy there are three books which consist entirely of symbolical pictures and accompanying epigrams. The first work published of this kind is the *Atalanta Fugiens* by Michael Maier, which appeared in 1617 and was subsequently reprinted several times. This book contains 50 engraved plates that purport to give a description of the Alchemical process in terms of the symbolism of classical mythology, as it was understood by certain writers, for the most part Italian, who interpreted the gods and goddesses and their attributes as forces of nature, a conception

³ Venice, 1546.

⁴ Included in the *Museum Hermeticum Reformatum*, Frankfurt, 1677. Also published separately.

⁵ In *Aureum Vellus*, by Trismosin, first published at Rohrschack, 1598.

⁶ Augsburg, 1616, and again in 1663.

⁷ The following works may be mentioned, all of which contain engraved plates: Khunrath, *Amphitheatrum Sapientiæ*, Magdeburg, 1608, and other editions; van Helpen, *Escalier Des Sages*, 1689; *Mutus Liber* by Altus, La Rochelle 1677, and included in Manget's collection.

revived during the Renaissance by Petrarch and others⁸. The emblems are accompanied by a line of text in Latin and German, by an epigram, and a 'discursus' of several pages, while on the page opposite the picture there are a German translation of the epigram and musical notes with the words of the same epigram. The appearance of music in an Alchemical work is so startling that a modern author has given an interesting and somewhat detailed account of this book⁹. Nevertheless, it should be remembered that the circle of



FIG. 1.

Rudolf II, to which Maier belonged, sought to model itself on the sodalities of 15th century Florence¹⁰. There, in a society imbued with neo-platonic and pseudo-pythagorean ideas, the border-line between music and the philosophy of science, especially the mysticism of science, was very thinly drawn. The old Rosicrucian dictum 'Play sweet music during the process of the Great Work'

⁸ Especially in the works by Carteri, Valeriano and others, whose mythological folios might in some respects be regarded as the forerunners of the books of emblems.

⁹ Read, *Prelude to Chemistry*, London, 1936. See also: Craven, *Count Michael Maier*, Kirkwall, 1910.

¹⁰ See Will-Erich Peuckert: *Pansophie*, Stuttgart, 1936.

probably had its origin in the neoplatonic Sufi orders of the Islamic world, whence it was adopted by the scientific clubs of the early Renaissance.

The illustration on p. 71 (fig. 1) represents the episode of Œdipus and the sphinx. Maier's explanation is that Œdipus overcame the sphinx, killed his father and married his mother; the Alchemical 'solution', Maier continues, is as follows: the Stone is a triangle in essence and a quadrangle in quality.

In 1624 Luca Jennis at Frankfurt published a work containing 107 engraved emblems, each with a recondite text in verse form, all of which represent some aspect of Alchemy, either in its practical form or in its purely speculative manifestation. This book is the *Viridarium Chymicum* by Daniel Stolcius de



FIG. 2.

Stolcenberg¹¹, and a Latin and German edition were issued in the same year¹². In 1627 Jennis published another book, this time of 160 small Alchemical emblems, also by Stolcius, the *Hortulus Hermeticus*. These two books, which follow the emblem-book tradition much more closely than the *Atalanta* by Maier, can only be appreciated if the attitude of the 17th century mind towards Alchemical and philosophical concepts is taken into consideration. The 16th century had been an age of search for new forms of inner experience, but the 17th century overcame this diffusion of mental energy and definitely

¹¹ See Read, *Prelude to Chemistry*, for detailed information about this book and the *Hortulus*. The German edition of the *Viridarium*, however, which I have seen, is dated 1624.

¹² A reprint has been issued: Chicago, Aries Press, 1937.

adopted certain fundamental facts with reference to a self-analysis of the individual. The books of emblems gave expression in their own way to this craving for what we should call today a new psychology, which, perhaps, could not be expressed in words.

The most subtle works of the whole emblematic literature are, without any doubt, these two books by Stolcius. They endeavour to depict an attitude of mind rightly named Pansophia, an attitude that had risen above the embarrassments of conflicting faiths and that, for a brief number of years, attracted

8

HORTIVS

I
HERMES TRISMEGISTVS
Ægyptius.

*Quicquid in aethereo clauisum reperitur Olympo,
Nil aliud huius proprios feritque foresque fines.
Quicquid Terra tenet, Celum tenet id quodque Verum,
Caluisti talesti sed proprio illa modo.*

II.

ADFAIR ALEXANDRINVS PRÆ-
ceptor Moricæ.

*Cynthius est nostri thalami Pater atque Maritus,
At Coniunx nicens Cynthis cuncta comis.
Filius hocce foro tenera generatur in aura,
Effigie Matræ præditus atque Patris.*

III.

CLEOPATRA ÆGYPTI REGINA.

*Enthea via Sophia est, quam summi larga Tonantæ
Dextera præcepto ponit in Orbe loco.
Hanc tamen occultat ne fiat prædo malorum.
Rara datur raris tanta Corolla viris.*

IV.

MEDERA FOEMINA ALCHY-
mistica.

*Quisquis Alibia non nobis Regna beata,
Nescit is Hermetus vascula mira Senis.
Verum Natura lento vestigia passu
Qui sequitur, veras vase videbit opes.*

Quod

HERMETICVS.

9



*Quod est superius est sicut id quod est inferius.
Sol Coniugij nostri est Pater, Mater vero Luna alba.
Dignum est de Sapientia Domini, gentibus occultatum.
Qui nescit regimen veritatis, ignorat Vus Hermetis.*

A 5

FIG. 3.

the rare spirits of every country. An attempt was made to transfer the methods of empirical science from the realm of matter to that of the individual, and in doing so, of course, long-forgotten fragments of older faiths and experiences were resurrected and partially adapted to the Christian religion. The languages of the day were inadequate to express this transformation of Chemical empirical methods into a system that was purely subjective, so recourse was had to pictorial symbolism in book-form. These two books might be said to represent the ideas of European speculative Alchemy more concisely than any written

treatise, without the appendage of words whose meaning has been lost, showing only the fundamental symbols which will some day be again understood when more is known about the system of thought that created these pictures. Here is the Alchemical process described in its entirety. The books are the end of a tradition that began in the 12th century, for no new ideas were evolved later and no works were published on which so much care and thought were lavished as on these two books by Stolcius.

HERMETICVS

33



Patri & Matri tertius succedit qui est gubernator Ignis.

Fumus complectitur fumum, & herba in montibus capit utrumque.

Matrimonium fit in duobus gummis Albo & Rubeo.

Quod aduersus Ignem pugnat, est Sulphur, quod ipsum sustinet est Mercurius.

FIG. 4.

The illustration on p. 72 (fig. 2), taken from the *Viridarium*, shows the action of the seven metals in their planetary aspect on the perfect human being, the word *rebus* in Alchemy always referring to the bisexual, that is to the perfectly balanced individual. By this balance a victory is assured over the dragon, and the square and the triangle, 4 and 3, are united into the mystic number 7, the number of attainment that gives the adept domination over the forces of the earth which has now become "volatile," that is, transformed; this is the meaning of the wings. This conception of man and the cosmos is found in

HERMETICVS.

165



Nisi argentum viuum mortificetur cum Corpore occulto, nil valebit.

Quam primum filius cum Matre concumbit, viperino conatu eum occidit.

Hæc scientia non est nisi de occultis Sapientum Præceptorum ac Philosophorum.

Hoc est in Magisteriis ac diuinis viis ambulare, comite Domino nostro Iesu Christo.

LAVS DEO.

FIG. 5.

older systems of thought, in the Kalaçakra Tantra of Mahayana Buddhism, in Manichæism, among the Stoics, and even, in a more veiled form, in Christian mysticism.

The illustrations shown as figs. 3, 4, and 5 (pp. 73 & 74) are taken from the *Hortulus*. The first page of the book is given to show the scheme of the texts and the four emblems on the opposite page. The interpretation of these emblems is difficult, if not impossible, at present, for we do not know what system and what sequence underlies these 160 pictures. It is possible to give a philosophic meaning to a certain number of the pictures, as has been attempted in the case of the illustration taken from the *Viridarium*. But that is not enough. The pictures probably represent mental states of experiences which we today are unable to comprehend, and perhaps they even refer to actual chemical experiments used in a way that would be utterly rejected by our modern scientific system. We should like to know why the names of certain Alchemists were chosen and why the Hermetic maxims were placed around one emblem and not another.

With the beginning of the industrial age the use of symbols has been discarded in Europe. It is true that lately attempts have been made to re-interpret the symbolism of the past from the point of view of psychology, but the dangers here are those of a false rationalism. The symbolic pictures in the two Alchemical books by Stolcius probably represent experiences with which the intelligent student could identify himself, and it is this extension of the self which may be the key to a real understanding of symbolic Alchemy.

SOME EARLY CHEMICAL SYMBOLS.

By D. McKIE, D.Sc. Ph.D.

Early examples of the use of Chemical Symbols are found in the *Basilica Chymica* of Oswald Croll (1609)¹ and in the diary written by Robert Hooke during the years 1672 to 1680 (*The Diary of Robert Hooke*, edited by Robinson and Adams, London, 1935²). [Slides of these symbols were shown.] A more extensive use of symbols was made by Lemery in his famous *Cours de Chymie* (Paris, 1675, and later editions³). Lemery's symbols were quoted by John Harris in the article 'Characters' in his *Lexicon Technicum* (London, 1704), the first technical dictionary, Harris's 'Characters Chymical', being reproduced here (see p. 76). Harris, apart from much needed typographical improvement, effected another change, namely, the omission of the zodiacal signs that Lemery had included in his list. Otherwise the symbols of Harris are those of Lemery :

¹ See J. R. Partington, *Everyday Chemistry*, London, 1931, p. 140.

² Pp. 2-3.

³ The symbols do not occur in the earlier editions.

to represent the rising and the setting sun. ' Wheel Fire ', according to Harris, ' is the same with what the Chymists call *Ignis Rotæ* ; that is, a Fire which covers the Crucible, Coppel, or Melting-pot, entirely over ; at top, as well as round the Sides ' : and ' Gravelled Ashes ' are ' the Lees of Wine dried and burnt to Ashes : So that they are a kind of Calcined Tartar '. The symbols for glass, for hour and for marcassite (the thunderbolt) are of obvious origin. It may be noted that the symbols for sublimation and precipitation are incorporated with the symbol for mercury in order to represent mercury sublimate (now corrosive sublimate) and mercury precipitate (now calomel), although the former had already been thus represented by Croll.

THE AUREA CATENA HOMERI.

By GERARD HEYM.

THE view of Nature which was advanced by Paracelsus and others of his school had developed along two separate lines of thought. The first, rationalistic, and leading to the elaboration of modern science; the second, metaphysical, or, as we prefer to call it to-day, 'pneumatic', further developing on the one hand into the theosophic school founded by Böhme, and on the other hand into the school of practical metaphysics, which united with the existing alchemical tradition.

The *Aurea Catena Homeri*, first published in 1723, affords the best example of the latter school of thought, and a proof that the victory of rationalism was not so complete, at first, as is popularly supposed to-day. Opposed to the new rationalism were religious doctrines and also this school of thought, with all its philosophical implications and additions; and, by publishing this book, the devotees of the 'Art' made a last attempt to combat the new thinking. The *Aurea Catena Homeri*¹, the *Golden Chain of Homer*, or the *Annulus Platonis*, as it is also called, is one of the most logical and readable books among a hundred books more or less absurdly speculative. It has a third title, *Superius & Inferius Hermetis*, which is added in the edition under consideration. This book was read in all German-speaking countries, and for two generations remained the most popular work of a dying tradition². For soon German metaphysical speculation was to lose its cosmic character and become the handmaiden of a new philosophy, while the victory of the Encyclopædists has lasted to our own day.

The first title is taken from the *Iliad* viii, 17-26. The idea of a 'chain' is not uncommon in alchemical philosophy, as the alchemists believed that, in nature, all created phenomena are chained to one another, and therefore in an occult connection with one another within the ever-changing but constant circulation of the cosmic forces. The *Ring of Plato* suggests the same interpretation of nature, 'Plato' here, perhaps, being used in the Neo-pythagorean sense, while the third title, *Superius & Inferius Hermetis*, has, of course, reference to the Smaragdine Tablet of Hermes.

The edition which is being discussed is the last one, dated 1781. It is the most interesting because it contains valuable notes by the editors, who were

¹ Dr. Ferdinand Maack, *Die Goldene Kette Homers*, Lorch, 1905. An excellent little book, giving a detailed description of the *Aurea Catena*. Dr. Maack establishes the authorship of Kirchweyer, which confirms Kopp's researches. Hermann Kopp, *Aurea Catena Homeri*, Braunschweig, 1880; Ferguson, *Bibliotheca Chemica*, i, 35 & 469.

² There were twelve editions in Germany. The French edition is more of an adaptation than a translation. It is entitled *La Nature Devoilée*, Paris, 1772, 2 vols.

members of the last pansophic society of Germany. This society still included men of learning³ who claimed to carry on an unbroken tradition from the distant past. That this past was not so 'distant' we know now, because these societies in Germany had their origin in the Florence of Ficino and Cosimo de Medici.

The complete title of the book is as follows : *Annulus Platonis, or physico-chemical Interpretation of Nature according to Her Origin, Preservation and Destruction, by a Society of genuine Natural Scientists, again improved and edited, with many important notes.* This is followed by a full-page reproduction of the Hermetic Tablet in 'Phœnician' letters⁴; by a diagram of the 'chain', with a note in prose on the opposite page; by a symbolic diagram entitled 'Die Figur Abyssi Duplicatæ, or of the double volatile and fixed abyss'; and finally by two poems, one describing the 'Chain', the other the 'Abyss'. A very rhetorical preface by 'Phlebochron', filled with Hermetic allusions, follows, and then the table of contents is given. The book is divided into two parts: the theoretical, 'De Generatione Rerum', and the practical, 'De Corruptione Rerum et Anatomia Rerum'. A third part, which appears in some editions, is, according to the editors, spurious.

The philosophy of Alchemy is described in outline in the illustration of the 'chain', where every 'link' has a Latin description. This is worth reproducing here because it represents the fundamental theory of Alchemy on which this book and so many other alchemical works are based. There are ten 'links':

Chaos confusum.
 Spiritus Mundi volatilis incorporeus.
 Spiritus Mundi acidus corporeus.
 Spiritus Mundi fixus alcalicus corporeus.
 Materia prima omnium concretorum sublunarium immediata seu Azoth.
 Animalia.
 Vegetabilia.
 Mineralia.
 Spiritus Mundi concentratus fixus sive Extractum chaoticum purum.
 Perfectio consummata sive Quinta Essentia.

A more detailed description⁵ of the alchemical interpretation of natural phenomena according to the words of *Aurea Catena* is as follows:

The inconceivable First Cause.

The creative word 'Fiat'; the divine emanation, Mercurius Vitæ.

³ Reference might be made here to Dr. F. J. Chevalier Varmêrp, *Die Statuten der Aerzte der Höheren Medizin*, Bonn, 1888.

⁴ Julius Ruska, *Tabula Smaragdina*, Heidelberg, 1926, pp. 227-8,

⁵ Taken from the outline in Dr. Maack's book,

Invisible Spirit, spiritus mundi incorporeus.

The beginning of all things, the volatile seed of the cosmos, the primal seed of the universe.

The visible Steam, Fog, Smoke ; the primal steam of the universe.

The Chaotic Water.

The primeval water of the universe, the primordial Water, Mercury of the Wise, fiery Water, watery Fire, Shamajim, Azoth.

Abyssus superior seu volatilis.

The source of all separate phenomena. Hermaphroditic Mercury.

(This is composed of :

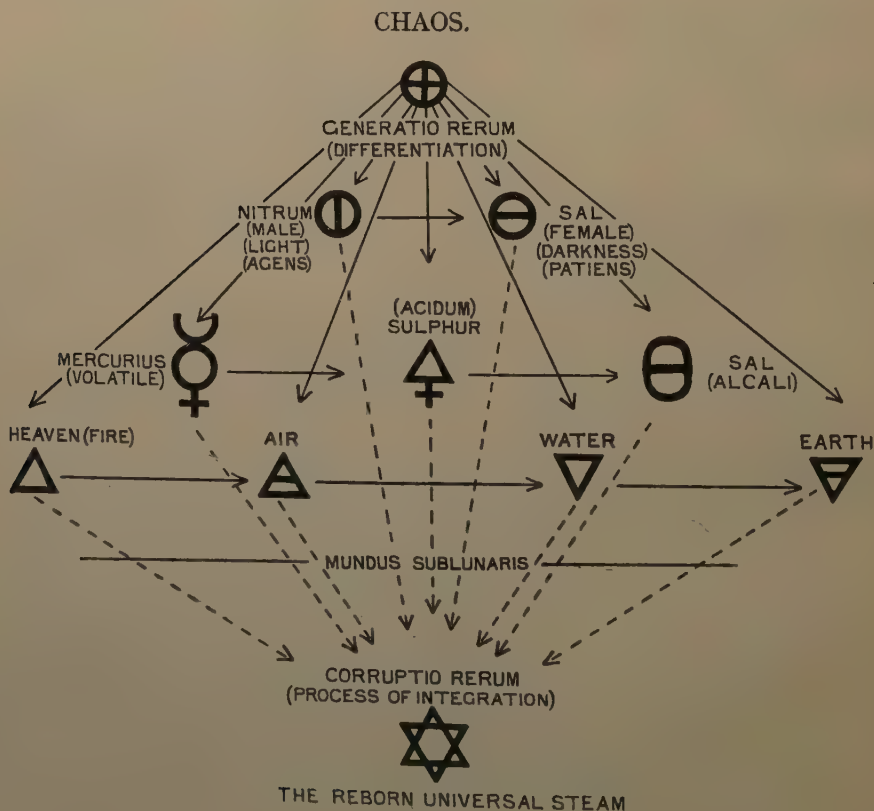
Invisible Spirit plus visible Water.

Active Spirit plus passive Body.

The 'causator', the mover plus Instrument, receptacle.)

The great 'Nothing', Void.

Prima Materia, primordial Matter.



THE REBORN CHAOS.

The reborn Chaotic Water.

Prima materia regenerata.

Abyssus inferior seu fixus.

The fixed Universal Seed.

Spiritus mundi concentratus fixus.

Quinta Essentia.

Magisterium. Arcanum.

Universal Medicine, for human beings and base metals.

It will be seen that, beginning with the word CHAOS to the phrase THE REBORN CHAOS, a diagram has been inserted. This diagram represents the exact position of the Art of Alchemy in the scheme of the cosmos as conceived by this philosophy. Alchemy assists Nature and improves the phenomena of nature by 'art'. This is done by 'resolving' and by 'fixing'; that is, by reducing a substance to the primordial chaos by means of the 'Quinta Essentia', and the result is that the ingredients will be automatically put together again in such a way that the new substance will be a very great improvement upon the old. The scheme of the cosmic forces as it is given here is reminiscent of the angels of Dionysius the Areopagite, except that the angels have again become emanations and abstractions, as they once had been with Proclus and the late Neo-platonists. But what is not, strictly speaking, Neo-platonic is the idea of the creation of a third cosmos, which is possible for the 'artist' in the alchemical sense or for the adept to produce.

This conception we find among the Arabs⁶. There it is the divinely inspired Imam who can create a third cosmos, and he is permitted to do this in order to produce tangible proof of the glory of Allah. That is his sole justification for the practice of Alchemy. He wants to show mankind all the marvels of the cosmos and produces the *elixir* in which they are visible.

This doctrine is condemned by the orthodox Sunnis, as its origins are gnostic, and also go back to the lunar magic of Harran and the world of Persian-Arabic culture as distinct from the Byzantine civilization⁷. To the European mind the idea of the individual assuming the creative abilities of the Deity and producing effects that are beyond the confines of ordinary human endeavour has always seemed either blasphemous or ridiculous. And yet the alchemists have succeeded to some extent in uniting their Neo-platonism with the belief in the powers of the 'adept', and this fact is brought out in the above diagram.

From the first cause emanates the Logos, which manifests gradually and becomes the 'Chaotic Water'. Incidentally, the author of *Aurea Catena* here claims Thales as an alchemist. This water is a kind of physical matrix

⁶ E. O. v. Lippmann, *Entstehung und Ausbreitung der Alchimie*, Berlin, 1931, ii, 76.

⁷ Ruska, *op. cit.*

out of which emanates the undifferentiated seed which later separates and produces the different objects of cognition. The 'Chaotic Water' is so important in this book that the author gives it a special meaning, that of 'Abyssus superior', another name for the philosophical void—that is, in the sense used here, it is meant to describe the undifferentiated state. This undifferentiated state is the *Prima Materia*, the *Chaos*, and now we come to the important point where the human mind enters into this cosmic scheme as an active agent. Instead of allowing the cosmic forces to take their natural course and produce imperfect specimens—nothing perfect can be created by nature alone, according to this philosophy—the human mind can now make use of its divine birthright and produce perfect specimens.

This is done by altering the course of nature, that is, by separating the *Chaos* into its two basic constituents, 'Sal' and 'Nitrum', the male and the female. The 'art' of doing this consists of introducing a minute quantity of the 'Quinta Essentia', the 'Prima Materia', into the substance. This at first reverses the process of generation, that is, the substance is reduced to *Chaos*; the *Chaos* is 'separated' and a new generation follows, resulting in a 'perfect' specimen of the substance. In the scale of metals gold is the most perfect, therefore a drop of the 'Quinta Essentia'—or a particle of the 'Lapis Philosophorum', the solid state of the same 'Prima Materia'—'projected' into any molten mass of base metal at once turns this into the purest gold. Or a drop of the 'Quinta Essentia' mixed with a liquid and taken by a patient will cure him forthwith. The *Aurea Catena* is more interested in the iatrochemical aspect of Alchemy than in transmuting metals, therefore the aim of Alchemy must be the preparation of universal medicine. But the real aim of the author is to produce spiritual perfection, and this is only possible by giving mankind healthy bodies. Hence the necessity of Alchemy. The author is also a child of the eighteenth century in that he wants to create a state of happiness for the greatest number; especially does he want to help the less fortunate classes.

The theory of the preparation of the 'Quinta Essentia', according to the *Aurea Catena*, is more philosophical than that found in the usual alchemical works.

The Chaotic Water is composed of two inseparable parts, here called Spirit and Water. This Water further evolves into the Elementary Water, the opposite of the Heavenly Fire, into which spirit has evolved. This Elementary Water is contained in Ordinary Water, in dew, rain, snow, frost, hail, etc., substances that are the best raw material for the 'artist' for the preparation of the 'Elixir', or the 'Quinta Essentia'. When it comes to instructing the neophyte in the 'art' of the preparation of the 'Elixir' the reader will find himself helpless before the usual wall of technical terms. Certain directions are given with reference to rain-water; for example, one should let it stand for a long time and observe the results. At the beginning of the book we

at once find the important phrase, *non transiri posse ab uno extremo ad alterum extremum absque medio*. And later, *sal metallorum est lapis philosophorum & basis totius artis*. To obtain the 'sal metallorum' the 'medio' is necessary. This 'medio' is for us the unknown quantity; the author of our book speaks of it as a superior kind of awareness, or, as our modern psychologists would say, it is the 'pneumatic factor' without which a comprehension of the technical terms of Alchemy are impossible.

The *Aurea Catena* has all the characteristics of the usual alchemical work except that it is more philosophic in its language. Its aim is to give the reader a concise philosophy of nature on a scientific basis as it is understood by the alchemists. But what is interesting is that even this book really uses a philosophic cloak to conceal its real object, the preparation of the Elixir by extra-human means. The real 'art' of the book is this technique of concealment, and this it has in common with all works of a 'pneumatic' character, whether they be written in Tibetan about the *Çintamani*⁸, hidden beneath the more or less respectable tenets of Mahayana Buddhism, or whether the subject is the practical mysticism of the Sufis, clothed in words of quite the opposite meaning. The alchemists will argue that concealment is necessary; perhaps they are right, but their point of view does not agree with that of the democracy of science. Rather does it lead us back to a certain free-masonry of scholarship of the past.

⁸ The Philosopher's Stone.

REVIEWS.

Origins and Development of Applied Chemistry. By J. R. PARTINGTON, M.B.E., D.Sc. Pp. x+597. Longmans, Green & Co. 45s.

THIS book is the most important work which has as yet appeared on the early history of science. The title gives no idea of the scope of the book, for the term 'Applied Chemistry' is here taken to include all that has any connection with that subject. In the words of the author's preface, 'The intention of the present work is to give a reasonably concise and systematic account of the sources, production, and uses of materials in Egypt, Babylonia, and Assyria, the Ægean, Asia Minor, Persia, Syria, and Palestine from the earliest times to the end of the Bronze Age.'

This enormous field involves studies of mining, metallurgy, and the use of metals and alloys; of stone, ceramics, glass, plaster, and stucco; of pigments, painting and enamels; of the use of such materials as salt, soda, alum, and sulphur; of textiles and their dyeing; of perfumes and incense; of oils, beer, leather, ink, soap, and many other materials. The survey of so great a mass of material could have afforded the stuff for many bulky volumes. The compression of it into a volume of six hundred pages has meant that every sentence carries an important fact. In spite of this, the book remains interesting and readable. A valuable feature is the prefixing of each section by a brief, yet modern and accurate, historical sketch of the culture concerned; to those who are scientists rather than historians the account of the chronology of the ancient peoples is of great value.

A survey of the whole work gives a remarkable impression of the great antiquity of most of the familiar crafts. A century ago the history of technology began in Greece and Rome: to-day we see that these received from more ancient peoples the tradition of the crafts which underlay their civilization. More and more do we find ourselves attributing the basis of civilized life to that marvellous period of the flowering of human genius—the Old Kingdom of Egypt.

The accuracy of such a work as this is beyond the power of any reviewer to test: an extensive use of the book has revealed no more than minor typographical errors.

The references to authorities constitute a great part of the value of an historical work of this nature. Professor Partington has provided some 25,000 references which are of particular usefulness, since they refer only to accessible volumes containing a definite contribution to the subject in question. These copious references and the five indices of Authors and Publications, of Persons and Nations, of Places, of Subjects, and of Greek words and names render this book a most valuable instrument of research.

[F. S. T.]

Prelude to Chemistry. By JOHN READ. Pp. xxiv+328 Illustrations and plates. London, 1936: George Bell & Sons, Ltd. 12s. 6d.

THE aim of this book is 'to offer a bird's-eye view of Alchemy, chemistry's precursor, followed by a closer glimpse of certain fields of that richly coloured panorama of the ages'. Its value lies in the 'closer glimpse of certain fields'; in other words, the early chapters on the origin and literature

of Alchemy are rather slight, whereas the remaining chapters, in which Professor Read discusses certain Alchemical authors and their works, are very well done, even if no attempt is made to penetrate beneath the surface of the subject. Nevertheless, since the work of Kopp no such comprehensive treatise has been written about Alchemical works; in fact, Professor Read has done the study of Alchemy a service by reviving an interest, above all, in the illustrated books of the 17th century. He has included many excellent illustrations and reproductions of plates taken from old books, and these enhance the usefulness of his work, for there is no other modern author who has enabled the student to acquaint himself with the pictorial symbolism of Alchemy.

In Chapter I an historical outline is given of the whole subject of Alchemy. Unfortunately, the author suffers from the popular misconception that our modern scientific ideas are the result of a very long tradition of thought and experience beginning with the nations of the ancient world, whose existence is justified because they assisted in creating our modern world of scientific achievement. Therefore he is given to projecting a mental pattern on to a subject which is indeed related to the science of today, but only related distantly. Historical chemistry and Alchemy in their experimental aspect have been a prelude to modern chemistry in that they inspired the empirical phase of the European mind. But they were never experimental in the modern sense. What we designate by Alchemy represents a tradition of thought greatly at variance with the dominating scientific and philosophical systems of European civilization. In former centuries, when the experimental mania of our time was to some extent restrained by a sincere religious faith, Alchemy attracted the finest minds—Newton, for example—because here was supposed to be found a way whereby science could be used for the perfection of the human spirit. From this point of view Alchemy seems to be an attempt to transfer chemical symbols from the experimental laboratory to human experience. Professor Read does not bring out this fundamental fact of Alchemy, but he gives us valuable historical details and an interesting time chart, in which, however, the probability of a remote Egyptian origin might have been mentioned, which, if established, would refute the theory of the Chinese origin of Alchemy.

In Chapter II a good *résumé* is given of the most important Alchemical works, with especial reference to manuscripts. As an example of industrious copying of old texts and even books by hand, the late Mr. Hockley might also have been included. There are many manuscript copies of old Alchemical books in the booksellers' shops, which, perhaps, as Professor Read says, is due to the fact that at one time these books were extremely scarce. The section devoted to Khunrath and the 17th century is interesting, but mention ought to be made of the 'Pansophic' societies of Germany before the Thirty Years' War, the source of so much of this type of literature. If this is remembered, an author like Khunrath does not appear to be so fantastic, for he was part of that mystical and philosophic state of mind of which Böhme was the greatest exponent. Incidentally, this latter writer, the greatest theoretical Alchemist of the 17th century, is not mentioned in Professor Read's book.

Chapter III, entitled 'The Philosopher's Stone', gives an account of the underlying theory of the Stone of the Philosophers. Reference is made to various names and designations of the Stone, and, as always, Professor Read gives full bibliographical details in his excellent notes at the end of the book.

Pernety's table on p. 136 might be compared with that in the work by 'Rosarius Minor' in the collection in folio by Gratarolus, and also to the one given by the Sufi mystic Mahmud Shebisteri, translated by Redhouse. The sections on 'Fire' and on 'The Sequence of Colours' are important and well documented, but the discourse on the influence of the stars might have been given in fuller detail, because the basis of the Great Work is always the action of the macrocosmos on the microcosmos. In the next section a detailed account of the plates of the *Mutus Liber* is given, with an interesting theory as to the reputed author. The chapter ends with a discourse on the relation between mythology and the Stone and the quest of those in search of the Stone.

The next four chapters are the most important in the book and consist of valuable contributions to our knowledge of the bibliography of Alchemy.

Professor Read first discusses the collection of Alchemical works known as the *Hermetic Museum*, which also contains interesting plates. This is followed by the *Tripus Aureus* of Michael Maier, with a dissertation on the Lully tradition in England, in which material is given that has been taken from little-known sources. The next section describes Norton's *Ordinal* and an account of that author's suggestions to Alchemists.

There is a very long and informative chapter on Basil Valentine and the works that go under his name, again supplemented with excellent bibliographical material. This author, who is a perfect instance of a combination of the practical chemist and the symbolic Alchemist, has never really been investigated by scholars, and Professor Read rightly draws attention to the pictures contained in one of the books by Basil and discusses their symbolism at length.

In the next chapter the emblematic plates prefacing the works of Libavius are examined with great care, and this is followed by a long and interesting account of the works and the personality of Michael Maier. Professor Read mentions the emblems in Maier's *Atalanta Fugiens* and gives his own interpretation of their symbolism, and he also draws attention to the musical notes in this work. Mr. F. H. Sawyer has contributed a treatise on this music on p. 281, in which he discusses the 17th century *Fuga per Canonem* and Maier's intricate use of it. Mr. Sawyer has also been instrumental in producing some of these 'fugues'.

In the last chapter Professor Read examines two forgotten books of Alchemical emblems, both by a certain Stolcius, and by doing so he has brought to notice two books that represent the climax, as it were, of symbolical Alchemical literature. The bibliographical details given in this chapter show proof of a wide reading and sound scholarship, which lead one to hope that the author will extend his researches to other phases of the symbolical literature of Europe.

[G. H.]

Orientalische Steinbücher und Persische Fayencetechnik. By H. RITTER, J. RUSKA, F. SARRE, R. WINDERLICH. *Istanbuler Mitteilungen*. Istanbul, 1935.

THE mineralogical literature of the Islamic civilization is of great interest to scholarship on account of its connection with the beginnings of European science. Prof. Ruska's work on the Arabian lapidaries is well known, and now we have Dr. Ritter with his vast bibliographical knowledge contributing an important article in this little book on Oriental lapidaries, and making an especial reference to the faience-technique of the Persians. This is followed

by the text and translation of a Persian description of the faience-technique of Kashan, the chief city in Persia for the manufacture of ceramics. The text is really the concluding chapter of a book about jewels and perfumes; it is dated 1301, when the art of pottery in Persia was at its height. It is the first translation of an Oriental work of this kind and its importance cannot be over-estimated. The author in his introductory sentence says, 'this technique is in truth a kind of Stone of the Wise'. The contents of the text are: a knowledge of the materials and necessities; a knowledge of the solutions of those materials (Prof. Ruska points out that 'solution' is also to be taken in its Alchemical sense); the knowledge of the composition of these materials. Prof. Sarre contributes the last article: a note on a ceramic workshop in Kashan in the 13th-14th centuries. There are four plates illustrating mihrabs decorated with faience tiles.

[G. H.]

Der Goldmacher Marco Bragadino. By IVO STRIEDINGER. Munich, 1928: Theodor Ackermann.

THIS very scholarly, though somewhat dull book, gives a vivid picture of the conditions of Italy during the 16th century. The central figure is the Greek Mamugnà, who called himself Marco Bragadino, a typical Alchemical adventurer and charlatan of the time, and who cleverly used the economic distress of the century to further his own ends.

Herr Striedinger explains that all the Italian potentates, especially the lesser ones, were desperately in need of money because of the influx of gold from the Spanish dependencies. This fact had changed the economic situation; Italy was no longer in a position of dominance. From Italy the hunger for gold spread to Austria and Germany, and that is why the Alchemical charlatan flourished in those countries.

Bragadino was famous in his day and we read of his splendid reception in Venice. Unfortunately, when the time came and the Signoria finally wanted a proof of his art, he was not successful. However, he bequeathed a 'secret process' to the Republic before he left for Germany. There, in 1591, he was hanged, the gallows having been decorated with gold-paper. The account of the trial is the most interesting part of the book. Bragadino was in many respects a victim of his age, an age which wanted professional Alchemists, and willingly paid thousands of ducats for promises.

Some years later the Republic of Venice was more in need of gold than ever. The Council of the Ten commissioned the German Alchemist Otto Tachen (Tackenius) to examine the manuscript and the powder left by Bragadino. Tachen found that the process was useless, Bragadino having merely copied a treatise by 'Aristotle', which can be read in vol. iii of the *Theatrum Chemicum*. To the disgust of the worthy senators, the powder would not even 'tinge'.

[G. H.]

THE VISIONS OF ZOSIMOS.

Translation and Prefatory Note by F. SHERWOOD TAYLOR.

THE Visions of Zosimos are contained in the texts¹ Ζωσίμου τοῦ θείου περὶ ἀρετῆς ; Πρᾶξις α', 1-5, πρᾶξις β' and πρᾶξις γ'. A short indication of their character has been given on pp. 42-44 of this journal.

Zosimos of Panopolis was perhaps the most important of the Græco-Egyptian alchemists. He is not mentioned by any non-alchemical author earlier than Suidas, who states that Zosimos and Theosebeia (his sister) wrote a work, *Cheirokmeta* (or *Manipulations*), a chemical encyclopædia in 28 books. Of this certain existing works of Zosimos are fragments. Zosimos probably belongs to the third century A.D. He cites Demokritos and most of the early authors, and also Africanus, who died A.D. 232. He is himself cited by Olympiodoros (early fifth century): he mentions the Serapeum, destroyed in A.D. 390, as if still in being. The general character of his allegorical writings is consistent with a third century origin, and probably his period of work centred round A.D. 300. Zosimos of Panopolis is not, of course, identical with Zosimos the historian.

He produced several works on Alchemy and a collection of some of the alchemical works extant in his time; a part of this collection survives in a fragmentary condition. It is difficult to tell how much of the work of Zosimos was original. There is no doubt that he had practical laboratory experience; but most of his extant writings are discussions of the experimental work of Demokritos and Maria. The Visions stand quite apart from his other writings, and indeed from all other Greek Alchemy, which contains nothing else of his elaborately allegorical character. They have indeed much of the character of actual dreams, which may indeed have afforded a basis, at least, for these writings.

ZOSIMOS. OF VIRTUE.

Lesson 1.

1. The composition of waters, the movement, growth, removal, and restitution of corporeal nature, the separation of the spirit from the body, and the fixation of the spirit on the body are not due to foreign natures, but to one single nature reacting on itself, a single species, such as the hard bodies of metals and the moist juices of plants.

¹ Berthelot, *Collection des Alchimistes Grecs. Texte*, 107-112, 115-118.

And in this system, single and of many colours, is comprised a research, multiple and varied, subordinated to lunar influences and to the measure of time, which rule the end and the increase according to which the nature transforms itself.

2. Saying these things I went to sleep, and I saw a sacrificing priest standing before me at the top of an altar in the form of a bowl. This altar had 15 steps leading up to it. Then the priest stood up and I heard a voice from above saying to me, 'I have accomplished the descent of the 15 steps of darkness and the ascent of the steps of light and it is he who sacrifices, that renews me, casting away the coarseness of the body; and being consecrated priest by necessity, I become a spirit'. And having heard the voice of him who stood on the bowl-shaped altar, I questioned him, wishing to find out who he was. He answered me in a weak voice, saying 'I am Ion, the priest of the sanctuary, and I have survived intolerable violence. For one came headlong in the morning, dismembering me with a sword, and tearing me asunder according to the rigour of harmony. And flaying my head with the sword which he held fast, he mingled my bones with my flesh and burned them in the fire of the treatment, until I learnt by the transformation of the body to become a spirit'.

And while yet he spoke these words to me, and I forced him to speak of it, his eyes became as blood and he vomited up all his flesh. And I saw him as a mutilated little image of a man, tearing himself with his own teeth and falling away.

And being afraid I awoke and thought 'Is this not the situation of the waters?' I believed that I had understood it well, and I fell asleep anew. And I saw the same altar in the form of a bowl and at the top the water bubbling, and many people in it endlessly. And there was no one outside the altar whom I could ask. I then went up towards the altar to view the spectacle. And I saw a little man, a barber, whitened by years, who said to me 'What are you looking at?' I answered him that I marvelled at the boiling of the water and the men, burnt yet living. And he answered me saying 'It is the place of the exercise called preserving (embalming). For those men who wish to obtain virtue come hither and become spirits, fleeing from the body'. Therefore I said to him 'Are you a spirit?' And he answered and said 'A spirit and a guardian of spirits'. And while he told us these things, and while the boiling increased and the people wailed, I saw a man of copper having in his hand a writing tablet of lead. And he spoke aloud, looking at the tablet, 'I counsel those under punishment to calm themselves, and each to take in his hand a leaden writing tablet and to write with their own hands. I counsel them to keep their faces upwards and their mouths open until your (*sic*) grapes be grown'. The act followed the word and the master of the house said to me, 'You have seen. You have stretched your neck on high and you have seen what is done'. And I said that I saw, and I said to myself, 'This man of copper you have

seen is the sacrificing priest and the sacrifice, and he that vomited out his own flesh. And authority over this water and the men under punishment was given to him.'

And having had this vision I awoke again and I said to myself 'What is the occasion of this vision? Is not this the white and yellow water, boiling, divine (sulphurous)?' And I found that I understood it well. And I said that it was fair to speak and fair to listen, and fair to give and fair to receive, and fair to be poor and fair to be rich. For how does the nature learn to give and to receive? The copper man gives and the watery stone receives; the metal gives and the plant receives; the stars give and the flowers receive; the sky gives and the earth receives; the thunderclaps give the fire that darts from them. For all things are interwoven and separate afresh, and all things are mingled and all things combine, all things are mixed and all unmixed, all things are moistened and all things dried and all things flower and blossom in the altar shaped like a bowl. For each, it is by method, by measure and weight of the 4 elements, that the interlacing and dissociation of all is accomplished. No bond can be made without method. It is a natural method, breathing in and breathing out, keeping the arrangements of the method, increasing or decreasing them. When all things, in a word, come to harmony by division and union, without the methods being neglected in any way, the nature is transformed. For the nature being turned upon itself is transformed; and it is the nature and the bond of the virtue of the whole world.

And that I may not write many things to you, my friend, build a temple of one stone, like ceruse in appearance, like alabaster, like marble of Proconnesus, having neither beginning nor end in its construction. Let it have within it a spring of pure water glittering like the sun. Notice on which side is the entry of the temple and, taking your sword in hand, so seek for the entry. For narrow is the place at which the temple opens. A serpent lies before the entry guarding the temple; seize him and sacrifice him. Skin him and, taking his flesh and bones, separate his parts; then reuniting the members with the bones at the entry of the temple, make of them a stepping stone, mount thereon, and enter. You will find there what you seek. For the priest, the man of copper, whom you see seated in the spring and gathering his colour, do not regard him as a man of copper; for he has changed the colour of his nature and become a man of silver. If you wish, after a little time you will have him as a man of gold.

Lesson 2.

1. Again I wished to ascend the seven steps and to look upon the seven punishments, and, as it happened, on only one of the days did I effect an ascent. Retracing my steps I then went up many times. And then on returning I could not find the way and fell into deep discouragement, not seeing how to get out, and fell asleep.

And I saw in my sleep a little man, a barber, clad in a red robe and royal dress, standing outside the place of the punishments, and he said to me 'Man, what are you doing?' And I said to him 'I stand here because, having missed every road, I find myself at a loss'. And he said to me 'Follow me'. And I went out and followed him. And being near to the place of the punishments, I saw the little barber who was leading me cast into the place of punishment, and all his body was consumed by fire.

2. On seeing this I fled and trembled with fear, and awoke and said to myself 'What is it that I have seen?' And again I reasoned, and perceiving that the little barber is the man of copper clothed in red raiment, I said 'I have understood well; this is the man of copper; one must first cast him into the place of punishment'. Again my soul desired to ascend the third step also. And again I went along the road, and as I came near to the punishment again I lost my way, losing sight of the path, wandering in despair. And again in the same way I saw a white-haired old man of such whiteness as to dazzle the eyes. His name was Agathodæmon, and the white old man turned and looked on me for a full hour. And I asked of him "Show me the right way". But he did not turn towards me, but hastened to follow the right route. And going and coming thence, he quickly gained the altar. As I went up to the altar, I saw the whitened old man and he was cast into the punishment. O gods of heavenly natures! Immediately he was embraced entirely by the flames. What a terrible story, my brother! For from the great strength of the punishment his eyes became full of blood. And I asked him, saying, 'Why do you lie there?' But he opened his mouth and said to me 'I am the man of lead and I am undergoing intolerable violence'. And so I awoke in great fear and I sought in me the reason of this fact. I reflected and said 'I clearly understand that thus one must cast out the lead, and indeed the vision is one of the combination of liquids'.

WORK OF THE SAME ZOSIMOS.

Lesson 3.

1. And again I saw the same divine and sacred bowl-shaped altar, and I saw a priest clothed in white celebrating those fearful mysteries, and I said "Who is this?" And, answering, he said to me 'This is the priest of the Sanctuary. He wishes to put blood into the bodies, to make clear the eyes, and to raise up the dead'.

And so, falling again, I fell asleep another little while, and while I mounted the fourth step I saw, coming from the East, one who had in his hand a sword. And I saw another behind him, bearing a round white shining object beautiful to behold, of which the name was the meridian of the Sun ², and as I drew near

² or of Cinnabar.

to the place of punishments, he that bore the sword told me 'Cut off his head and sacrifice his meat and his muscles by parts, to the end that his flesh may first be boiled according to method and that he may then undergo the punishment'. And so, awaking again, I said 'Well do I understand that these things concern the liquids of the art of the metals'. And again he that bore the sword said 'You have fulfilled the seven steps beneath'. And the other said at the same time as the casting out of the lead by all liquids, 'The work is completed'.
